# *Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement*

Steve Levy, County Executive

## Task 10: Suffolk County Vector Control and Wetlands Management Long-Term Plan

*Prepared for:*

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# SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT

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# TABLE OF CONTENTS

## TABLE OF TABLES



## TABLE OF FIGURES



## APPENDICES

# LIST OF ACRONYMS

| | |
|---|---|
| ABDL | Arthropod-Borne Disease Laboratory |
| Ach | Acetylocholine |
| AChE | Acetylcholinesterase |
| AMCA | American Mosquito Control Association |
| BOCES | Suffolk County Board of Cooperative Educational Services |
| CDC | Centers for Disease Control and Prevention |
| DDT | Dichloro-Diphenyl-Trichloroethane |
| EEE | Eastern Equine Encephalitis |
| FIFRA | Federal Insecticide, Fungicide, and Rodenticide Act |
| FINS | Fire Island National Seashore |
| GIS | Geographic Information Systems |
| IPM | Integrated Pest Management |
| MCC | Mosquito Control Commission |
| NYSDEC | New York State Department of Environmental Conservation |
| NYSDOH | New York State Department of Health |
| MEDFLY | Mediterranean Fruit Fly |
| OMWM | Open Marsh Water Management Plan |
| PBO | Piperonyl Butoxide |
| PCR | Polymerase Chain Reaction |
| PHL | Public Health Law |
| RAMP | Rapid Analyte Measurement Platform |
| SCC | Suffolk County Charter |
| SCDHS | Suffolk County Department of Health Services |
| SCDPW | Suffolk County Department of Public Works |
| SCVC | Suffolk County Vector Control |
| SEQRA | State Environmental Quality Review Act |
| SLE | Saint Louis Encephalitis |
| ULV | Ultra Low Volume |
| USEPA | United States Environmental Protection Agency |
| VCMS | Vector Control Management System |
| WHO | World Health Organization |
| WNV | West Nile Virus |

## OVERVIEW OF THE PLAN

*Abstract*

Mosquitoes impact human health and public welfare in Suffolk County. To alleviate these impacts, the Suffolk County Charter established a Vector Control agency, and charged it (in concert with the Department of Health Services) to protect the citizens of the County from disease and other deleterious effects of mosquito infestations.

This Long-Term Plan enhances the Integrated Pest Management (IPM) approach to decrease risks to human health and impacts to public welfare from mosquitoes and mosquito management. Simultaneously, the IPM approach reduces impacts to the environment and increases potential ecological benefits associated with the selected management techniques. The Long-Term Plan stresses public education and associated source reduction as key elements to achieve these goals, with progressive marsh management implementation being key to achieving significant reductions in overall pesticide use. The Long-Term Plan also relies on scientific surveillance of mosquito conditions to target mosquito problems that may remain through use of biorational larvicides. If adult mosquito populations of concern still exist, and the rigorous decision criteria are met, adult control with pesticides may be employed.

*Progressive Water Management*

As part of the Long-Term Plan development process, the County was able to implement a progressive water management demonstration project at Wertheim National Wildlife Refuge, the first of its kind on Long Island. This wetlands restoration project (using Open Marsh Water Management [OMWM] techniques, which stress improving habitat for fish to consume mosquito larvae) created a more diverse salt marsh that enhances wildlife and finfish habitat values. This is an alternative to maintenance of the legacy grid ditch system for mosquito control, and, where implemented elsewhere in the northeast US, has led to significant reductions in the acreage and instances of pesticide usage.

The Plan relies on employing 15 progressive water management Best Management Practices at the 4,000 acres of salt marsh that the County currently larvicides regularly to control mosquito

populations, and anticipates that up to 75 percent of the larvicide applications will be eliminated by this work.

These assumptions are supported by decades of experience at other northeast US salt marshes, and so far they have been validated by the first few months of observations at the Wertheim site. Progressive water management will serve as a linchpin for a vector control program that relies on natural processes to control its mosquito problems, and therefore one that will be able to substantially reduce pesticide applications.

This tidal wetlands management approach represents a dramatic change in County direction, from a commitment to ditch maintenance to a general presumption in favor of reversion as an interim policy. This change is predicated on the ability to implement the progressive OMWM strategies. Over 4,000 acres of salt marshes have been identified as presumptive candidates for OMWM, with an additional 4,000 acres slated for non-intervention for vector control purposes, although it is possible that wetlands in this category could have potential for restoration projects. The remaining 9,000 acres of County salt marsh will be assessed over the next 10 years, with appropriate management actions following on the assessments. All of these activities are slated to be completed over the next 12 years. In the interim, it is expected that ditch maintenance (when essential for public health or ecological reasons) will affect less than 50 acres of tidal wetlands per year. The pre-existing policy of "no new ditching" (except when necessary for restoration) will, of course, continue to be in effect, and any essential ditch maintenance will be conducted in accordance with criteria described in the Long-Term Plan.

This approach to managing the County's salt marshes not only can reduce pesticide usage, but will serve as a basis for managing the marshes in a healthier, more sustainable manner. Salt marshes have been identified as key features in the County's shoreline ecosystems, and clearly play a role in regulating water quality and sustaining estuarine food chains. Improving their overall health is a clear necessity for any overall restoration of the County's coastal environment.

*Scientifically-based Decision Making*

All marsh and mosquito management decisions will be based on scientifically-grounded data generation. The County currently has one of the most comprehensive surveillance programs for mosquito monitoring. This network this will be expanded, which will allow the County:

- to determine exactly where and how to reduce larval populations of mosquitoes to prevent mosquito problems from occurring;
- to look for the presence of and then further track the progress of mosquito-borne pathogens that can threaten human health;
- to prevent untoward impacts to public welfare from aggressive human biting mosquito populations that also threaten to transmit disease; and,
- to carefully and specifically target those mosquitoes that require treatment as adults to prevent impacts to human health, in accord with State and federal guidelines.

Surveillance activities have been the basis for mosquito management decision-making, and the plan, by augmenting existing networks, and establishing new means of testing mosquito populations and the effectiveness of its operations, will improve the County's ability to make crucial decisions based on best available information.

In addition, in a new approach to public outreach, the County will use these data to clearly and concisely explain to the public why it made particular treatments (*i.e.*, to document pre – treatment mosquito levels in relation to criteria which trigger treatment) and to demonstrate the efficacy of the control efforts. This will help the general public understand why particular actions were taken when they were, how effective they were, and to potentially appreciate the benefits received from progressive vector control.

*Plan Approach*

The Long-Term Plan follows the tenets of IPM. It is composed of 11 parts.

The first sets out the goals and objectives of the Long-Term Plan, identifies the mosquitoes found in the County, which ones represent potential problems for people, and gives the basis for actions by Suffolk County Vector Control to address any mosquito problems that may arise. It demonstrates the County's commitment through its vector control activities to decrease impacts to human health and public welfare, and to decrease environmental impacts while also restoring significant portions of the County's environment.

The second part of the Long-Term Plan focuses on public education and outreach, which, when successful, can eliminate the need for organized control activities. Public education focuses on two main objectives:

- ensure that residents take personal responsibility, as much as is possible, for deterring mosquito bites by avoiding mosquitoes, and using effective repellents as directed by the label when encountering mosquitoes;

- promote proper housekeeping, especially regarding standing water in the vicinity of homes and businesses, to deny pestilential mosquitoes the breeding habitats they need.

The third part of the Long-Term Plan addresses surveillance activities, which generate the data that allow for scientifically-grounded treatment actions. Surveillance defines where the mosquitoes are, and what diseases they may be infected with. The risk that they will impact the health and welfare of the citizens of the County can then be determined. The County is expanding its surveillance activities, and adapting them to face new issues, such as other emerging diseases and changes in the ways existing disease can be tracked.

The fourth part of the Long-Term Plan is source reduction, which is the most efficient means of addressing mosquito problems. Important programmatic elements include site inspections by Vector Control personnel, discarded tire management, and maintenance and upkeep of storm water systems. For example, proper efforts in these aspects of source reduction lead to decreased breeding opportunities for some species that are essential for West Nile virus propagation.

Source reduction also includes water management, and the stand-alone Marsh Management Plan has been appended to and made part of the Long-Term Plan. Water management is to be the centerpiece of the County's mosquito management efforts. Through water management,

elimination of the ability of mosquitoes to breed successfully in areas that are the source of the most aggressive, and, by some accounts, most dangerous mosquitoes in the County, will be accomplished. Progressive water management holds the promise of not only effectively controlling mosquitoes, but serving as a means of enhancing natural marsh health. Implementation of the Marsh Management Plan should improve biodiversity and concomitant marsh values, while also achieving vector control aims, and with less need for ongoing maintenance.

Biocontrols are also discussed in the Long-Term Plan. Inherent in progressive marsh management is the use of fish to control larval populations (thus reducing adult populations). The undeniable success of this biological control has raised many hopes that other, natural elements of the local ecosystem can be augmented or supported to provide consistent control of mosquitoes, as well. The evaluation of other mosquito predators showed that it was extremely unlikely that any can be implemented to achieve the degree of control necessary to reduce impacts from mosquitoes to human health and public welfare. Some fish species may be beneficial if released to carefully selected environments. The County will continue to educate itself regarding potential benefits from organisms that will prey on mosquitoes, and determine under what conditions they can be released to achieve acceptable control.

Pesticides are the most visible component of nearly all mosquito control programs, although mosquito control experts have long advocated an integrated approach to control. Pesticides have an important role in controlling populations of mosquitoes and the disease threat they represent, especially in a jurisdiction such as Suffolk County. Suffolk has so many larval habitats that eliminating them all is a practical impossibility. Because many larval habitats are found in protected wetlands with important environmental values, eliminating these habitats is not desirable. Therefore, pesticides will be needed to provide acceptable levels of control. Part 6 of the Long-Term Plan addresses larval control, which, because the organisms are concentrated in aquatic environments, is more efficient than control of adult mosquitoes. Part 7 of the Long-Term Plan discusses the procedures for identifying when adult mosquito control might be considered, and, if extensive criteria for applying pesticides are met, exactly how those applications might be made (see Overview Table 1, below). The decision making process

described here is consistent with and is based on guidelines published by State and federal health agencies.

## Overview Table 1. Adulticide Decision Parameters

| Type of Parameter | | Factor for Vector Control Applications? | Factor for Applications under Health Emergency? | Criteria | Comment |
|---|---|---|---|---|---|
| Basic Surveillance Parameters | Number of mosquitoes | Yes | No | Counts in light traps significantly above norm; landing rates; complaints | Not a fixed value; somewhat species specific; ~ 25 per NJ trap, ~ 100 per CDC trap; landing rate 5+/min.; complaints invaluable where traps are not set; intend to set CDC traps before all non-Fire Island applications |
| | Species present | Yes | Yes | Light trap content analysis | Information on basic mosquito biology essential: Vector Control targets aggressive biters; Health Emergency targets specific (bridge) vectors; ; intend to set CDC traps before all non-Fire Island applications |
| | Complaints | Yes | Yes | Number/location of calls | Evaluate in historic context; complaints must be supported with appropriate surveillance data; complaints document extent of problem better than traps can |
| | Historical population trends | Yes | No | Surveillance data records | Data patterns often signal that problem is about to abate, or is likely to worsen |
| Species Specific Parameters | Aggressiveness of target species | Yes | Yes | Documented biting patterns of trapped mosquitoes | Aggressive biters indicate greater problem, increased likelihood for bridge vector participation |
| | Activity patterns of target species | Yes | Yes | Documented host seeking patterns, flight ranges of trapped mosquitoes | Guides actual control decision; e.g., evening vs. later at night; day-time flying may inhibit control; spot treatments only effective for short flight range species; large flight ranges require applications to cover larger, continuous areas to be effective |
| | Vector Potential | No | Yes | Infection rate, vector competence, % mammalian meals of trapped species | Establishes relative risk for species present |
| | CDC Vector Index | No | Maybe | MIR, trap counts for all potential vectors | CDC light trap counts * MIR, summed over all vector species; higher index correlates to more human infections following week; requires high mosquito/human infection rates for use; can use only with multiple trap data sets |

| Type of Parameter | | Factor for Vector Control Applications? | Factor for Applications under Health Emergency? | Criteria | Comment |
|---|---|---|---|---|---|
| Species specific parameters, continued | Parity rates | Sometimes | Yes | Age (blood meal history) of biting population | For Health Emergency, high parity rates indicate majority of biters had prior blood meal – direct indication of increased Vector Potential; for Vector Control, an aging population, even if smaller, will be treated since it represents increasing vector potential |
| | Life Cycle Type | Yes | Yes | Trap analysis | Brooded mosquitoes eventually die off on own, continuous breeders build populations over season |
| Public Health Parameters | Bird testing | No | Yes | Presence/absence of virus | Provides early warning in terms of bird to bird transmission; documents active disease foci in County |
| | CDC mosquito pool testing | No | Yes | Presence/absence of virus | Amplification vectors provide early warning, document active disease foci in County; bridge vectors indicate virus present in human biting species, is signal that human health risk is imminent |
| | Veterinarian reports | No | Yes | Ill/dead target animals | Non-mammals provide early warning, document active disease foci in County; mammalian cases indicate virus present in bridge vectors, signal that human health risk is imminent |
| | Physician reports | No | Yes | Human cases | Realized human health threat |
| | Disease history | No | Yes | Number of human/ important animal cases in prior years | Indicates that local conditions are favorable for pathogen amplification and transmission |
| | Avian dispersal/migration patterns | No | Yes | Time of year regarding dispersal of hatch year birds and known migration periods | Identifies new areas for concern, signals need to control known bridge vectors |
| Climatic Parameters | Current weather | Yes | Yes | Temp = 65+<br>Wind < 10 mph<br>No rain | Application time decision |
| | Short-term weather forecast | Yes | Yes | Presence of fronts & storms; barometric patterns | Application planning |
| | Time of year | Yes | Yes | Spring, Summer, & Fall activity patterns for trapped mosquitoes | Species-specific behavior; generally, cooler weather retards activity, warmer weather increases activity; virus presence not as significant when activity decreases |

| Type of Parameter | | Factor for Vector Control Applications? | Factor for Applications under Health Emergency? | Criteria | Comment |
|---|---|---|---|---|---|
| Ecological Parameters | Environmental factors in target area | Yes | No | Environmentally sensitive settings (R-T-E species) | Prior mapping is essential to clearly identify all environmentally sensitive areas; usually addressed through NYSDEC; Town and other expert cooperation is sought |
| | Population | Yes | Maybe | Number of impacted people/population density | For Vector Control: no people means no problem; for Health Emergency, threat may be sufficient |
| | Application restrictions | Yes | In some settings | Farms; no-spray list; NYSDEC wetlands, wetlands buffers; open water buffers; FINS | Vector Control no-spray areas include crop areas, no-spray list, buffers – discontinuities may make application ineffective; FINS Health Emergency criteria are more stringent than County criteria |

The remaining four parts of the Long-Term Plan discuss how it will be implemented, including:

- establishing an administrative structure for vector control activities in both the Department of Public Works and in the Department of Health Services,
- describing how the technology necessary for implementation should be evaluated,
- developing a framework by which the Long-Term Plan can be adaptively managed (including continuation of the Steering Committee, Technical Advisory Committee and the Citizens Advisory Committee), and
- estimating the costs to the County of adopting the Long-Term Plan

One last section specifically describes actions that should be taken to enable implementation of the Long-Term Plan.

*Improved Vector Control*

An evaluation of surrounding vector control agencies and Suffolk County's current program (attached to the Long-Term Plan as an Appendix) describes the current program as one of the finest in the Northeast. Nonetheless, there was room for improvement, and the Long-Term Plan proposes to improve essentially all aspects of the current program, from public outreach, to data management, to pesticide applications. As has been mentioned, the adoption of more progressive water management techniques, which the County was by-and-large unable to implement earlier due to resource and regulatory issues, may reap the greatest benefits. However, all aspects of the Long-Term Plan will combine to reduce the risks to County residents from disease and mosquito control activities, and also lead to environmental improvements that may be our times' greatest legacy to future generations of County residents.

*Interagency Cooperation and Public Input*

This Long-Term Plan was the product of an open and extraordinary process that sought, and received, input from local, State and federal government agencies and officials, from non-governmental organizations concerned about mosquitoes, pesticides, and wetlands, and from

concerned individual citizens and citizen groups. Suffolk County has invested a great deal of money and time into the Long-Tem Plan, but could not have reached these goals without the input, suggestions, and hard work from many others, which it gratefully acknowledges. Overview Table 2 lists major accomplishments of the Long-Term Plan to date, and outlines how some of the technical elements led to components of the plan.

Overview Table 2. Long-Term Plan Accomplishments to date (September 2005)

| Plan Element | Accomplishment | Discussion |
|---|---|---|
| Public Education & Outreach | Project website<br>Literature Search<br>National conferences<br>Associated committees | All project output: www.suffolkmosquitocontrolplan.org<br>1300 pages, with extensive expert review<br>SETAC, AMCA, LI Geologists<br>TAC, CAC, Wetlands Subcommittee |
| Surveillance | Trap network improvements<br>Enhance larvicide & adulticide efficacy monitoring<br>WNV monitoring re-evaluation<br>EEE conceptual reevaluation | Refinement of a program widely acknowledged to be excellent. The result of literature search and input from national experts. |
| Source Reduction | Storm water management expansion from 15,000 to ~50,000 sites | Result of Early Action project |
| Water Management | Wertheim OMWM<br><br>Seatuck and Wertheim retrospective studies<br>Salt marsh mapping<br>Identification of unditched marshes<br>Salt marsh extent<br>Wetlands Subcommittee<br>BMP manual<br><br>Wetlands Management Plan<br>Conceptual re-evaluation of marsh systems | Designed, permitted, began construction on 80 acre salt marsh restoration<br><br>Early Action project: long-term influences on salt marsh health<br><br>First GIS map of Suffolk marshes to name them all<br><br>Recalculated County salt marshes (17,000 acres)<br>Collaboration between Towns, County, NGOs on wetlands<br>Design manual for Suffolk County OMWMs, including tie-ins between mosquito control, wetlands restoration, and Phragmites control<br>Plan to achieve salt marsh management<br>Recognition of uniqueness of each marsh system |
| Biocontrols & Other Alternatives | Field tests (garlic & rosemary oils, Mosquito Magnet) | Barrier systems & mosquito trap evaluations |
| Larvicides | Caged Fish experiment<br>Benthic survey<br>Paired marsh invertebrate experiment<br>Risk assessment of 3 current products | Field test of larvicide impacts; included fate & transport<br>Statistical comparison of treated and untreated invertebrate populations<br>5 pairs of marshes compared for invertebrate impacts<br><br>Calculation of human health and ecological impacts |
| Adulticides | Minimize usage, optimize control:<br>Application methodology re-evaluation<br>Caged Fish experiment<br>Adapco Wingman system<br>Risk assessment on current and potential products | Modeling revealed means to reduce off-target drift<br><br>Field test of adulticide impacts; included fate & transport<br>Purchased computer model to optimize pesticide applications<br>Calculation of human health and ecological impacts |
| Project Management | GIS construction<br><br>Data management re-evaluation<br>Public outreach emphasis<br><br>Personnel and capital needs evaluation<br>Remote sensing evaluation | Digitized and mapped SCVC records in relational databases<br>First digitized tidal wetland map<br>Digitized 21 PSAs characteristics<br><br>Need to communicate program effectiveness better<br>ABDL BSL-3 recommendation, staff augmentation, marsh restoration equipment identification<br>Can provide cost-effective coastal marsh monitoring |

Three major elements of the project have been three major field programs (the Wertheim OMWM, the Caged Fish experiment, and the characterization of 21 Primary Study Areas in fresh

and salt wetlands), the literature search, and the quantitative risk assessment. The literature search resulted in the completion of 26 separate reports, concentrating on the topics of Suffolk County mosquitoes, mosquito-borne disease, vector control, pesticides, and salt marshes. The literature search directly led to major operational improvements such as purchase of the Adapco real-time modeling and weather monitoring system for adulticide application guidance. This state-of-the-art system optimizes mosquito control while minimizing pesticide usage. The literature review also demonstrated that progressive water management, as practiced throughout much of the northeast US, can be successful as a mosquito control technique, and also used as a restoration means for salt marshes. The Literature Search proved to be the technical heart of the project.

In addition to the Literature Search, other written reports were produced as products of other specific project tasks. By far the most important of these was the quantitative risk assessment. This document related the quantifiable risks of impacts to human health and the environment from three currently used larvicides and four adulticide products, based on extensive modeling of pesticide applications, the subsequent fate of those products, and the receptors (human and ecological) that could be affected by their use. Associated with this quantitative assessment were evaluations of impacts from mosquito-borne disease, proposed water management actions, and impacts to human health and the environment from other pesticides use.

Ultimately, the risk assessment demonstrated that, in the absence of vector control, it is possible that 16 people might die in Suffolk County from WNV, and another 150 or so might become seriously ill. Risks from EEE, while not quantified, included opportunity for the most efficient mosquito vector of this disease to become infected, and so potentially result in human illness where one-third to three-quarters of those people who become infected might die. Conversely, the risk assessment of pesticides found no adverse human health impacts because of the relatively low exposure experienced by people to these control agents. Of the control agents evaluated, only the adulticides posed a potential risk to flying non-target insects, using extremely conservative worst-case assumptions. No actual impacts have been documented in literature, and a California study showed no impacts and suggests that mitigation is feasible. None of the agents evaluated showed any aquatic ecosystem impacts, with the possible exceptions of permethrin and malathion.

The Wertheim OMWM project was addressed as a collaborative effort among USFWS, Ducks Unlimited, and the County and its consultants. NYSDEC was persuaded to issue a permit to construct the wetlands restoration after two years of negotiation. Approximately half of the reconstruction was accomplished in March 2005; the remainder will be addressed in the fall. Extensive, comprehensive, and long-term monitoring efforts, begun two years before construction and slated to be continued for at least another two years, will carefully document this project. The County is hopeful that this project's success will lead NYSDEC to reconsider past requirements that have inhibited OMWM and similar progressive water management projects in Suffolk County.

The Caged Fish experiment was intended to be a field exercise to document effects of pesticides on representative fish and invertebrates. It evolved into a major effort to document the fate of applied pesticides from release to degradation, and to understand impacts to sentinel organisms in the water column. The effort required modeling, air sampling, efficacy tests, fish and shrimp survival and non-lethal impact studies in the field and laboratory, testing of approximately 100 samples of pesticides in water, sediments, and biota, to the part per quadrillion level in some cases, using highly specialized equipment and research-level techniques, and multivariate statistical tests to determine the import of all the data. The effort was led by researchers from Stony Brook University, Southampton College, USGS, and the County PEHL, together with other County employees and the Long-Term Plan consultant team.

In addition, the collaborative nature of the management plan process, with participation by interested parties in local, state, and federal government, and non-governmental organizations with both local and national ties, created a dynamic planning process that allowed for concerns to be raised, suggestions to be made, and expertise to be interjected. The Long-Term Plan is thus more than a critical examination of past County practices. It is the fruit of a complete reconsideration of vector control intentions and capabilities, in light of practical constraints based on available technology and existing infrastructures. The Long-Term Plan offered here is intended to implement a state-of-the-art example of Integrated Pest Management, where the twin goals of reductions in risk to human health and increases in environmental quality can both be achieved.

# 1. Goals and Objectives

## 1.1 Goals of the Long-Term Plan

The Suffolk County Vector Control and Wetlands Management Long-Term Plan has two goals:

1. decrease risks to human health and impacts to public welfare from mosquitoes and mosquito management

2. simultaneously reduce impacts to the environment and increase potential ecological benefits associated with the selected management techniques

These goals will be achieved by adopting a progressive mosquito management approach based on the principles of Integrated Pest Management (IPM). It should be understood that not all mosquitoes in all situations need control. Where control is deemed to be required, the Long-Term Plan uses a hierarchical approach to mosquito management:

- scientific surveillance to determine the locations and types of mosquito problems
- source reduction, including the use of water management to modify habitat to minimize mosquito breeding, is paramount
- when breeding occurs, larval control using products that have no human health effects and little environmental impacts will be undertaken
- if mosquitoes develop into adults, and an assessment of the problem finds that adult control is required, then products will be used that have little to no impact to people, have an acceptably small impact to non-target organisms, degrade quickly, and are effective at killing adult mosquitoes

## 1.2 Discussion

Suffolk County currently follows this hierarchical approach in its mosquito control program. The County intends, through adoption of the Long-Term Plan, to reduce risks to its residents and

improve overall County environmental quality through improvements in each of the major elements of IPM.

It is essential that professional, scientific surveillance of potential mosquito problems be undertaken. Without timely information of the highest quality, it is difficult to reach optimal decisions concerning mosquito control, and to generate public confidence in the decisions so made. Surveillance activities are intended to:

- describe the species and numbers of mosquitoes present in areas of concern
- accurately define the locus of mosquito activity
- document the stage of the mosquito, if immature, or its parity (whether or not it has laid eggs before), if adult
- determine the presence of pathogens in host and sentinel species and mosquito vectors (including amplification and bridge vectors, if relevant) (amplification vectors serve to increase the prevalence of disease in hosts, and bridge vectors transmit disease from hosts to humans)

Data collected in the field will be processed to information quickly, and, if possible, locally. It will then be disseminated to the proper officials in a format that will enable the information to guide control decisions regarding identified mosquito problems.

A mosquito problem is caused by a threat of disease and impacts to public welfare. Worldwide, mosquitoes are identified as the most important vector of human disease. Most of the human misery and death caused by mosquitoes is from the transmission of malaria. Fortunately, Suffolk County and the rest of the US managed to control this disease more than half a century ago. Although minor outbreaks of the disease still occur, the risks of malaria to Americans today are nearly non-existent. Similarly, other dread mosquito-borne diseases such as dengue fever and yellow fever are of only passing concern.

The mosquito-borne diseases of concern in Suffolk County right now are encephalitic arboviruses. The two of most concern are Eastern equine encephalitis (EEE) and West Nile virus

(WNV). Outbreaks of EEE, which can have fatality rates ranging from 35 to 75 percent, have occurred recently in New Jersey and Massachusetts. Although there has never been a diagnosed human case of EEE in Suffolk County, horses have died from the disease here as recently as 2003. In 1999, WNV was introduced into the country, with the first human cases and deaths occurring in Douglaston, Queens. WNV has now been found throughout the continental US, resulting in over 16,000 human cases with 665 deaths through 2004; four of the people who died were residents of Suffolk County. These encephalitides not only have the potential to kill otherwise healthy individuals, but non-fatal impacts can include neuro-invasive effects, which can be permanent.

It is also clear that there are numerous other mosquito-borne diseases that currently are not found in the US. The immediate lesson of WNV in Suffolk County is that local mosquitoes have the capacity to transmit exotic pathogens and pose a significant disease threat. It is understood that the introduction of invasive mosquito-borne disease here is not a question of "if," but rather a question of "when." This is because modern transportation has removed geographical isolation. Along with generating undeniable benefits, this facet of modern life also means that disease organisms are often only one airplane flight away.

In temperate climates, human disease is the culmination of a long series of epidemiological events that build in intensity over a period of months. This cycle can be aborted early in its development by careful control of the disease vectors. Waiting for the disease to become evident in people means that any control may be too late to be effective in preventing further human suffering.

The public welfare is directly impacted not only by diseases, but also by subclinical effects of mosquito biting. Mosquitoes are known to be infected by other viruses, bacteria, and pathogens and parasites, such as worms of various kinds, some of which are implicated in human illness and some where no such link has been found. The salivary fluids released when a mosquito bites typically cause welts, and can cause rashes and various allergic reactions. When encountering fierce human biting species of mosquitoes, such as the salt marsh mosquito found in Suffolk County, the typical reaction of most people has been avoidance. Areas renowned for their mosquito populations, such as the south shore of Long Island, the New Jersey coastline, and

large portions of Florida, were largely uninhabited and undeveloped until effective mosquito control was instituted.

A mosquito comes into contact with blood when it bites, and in areas where there is disease transmission risk, there can be no clear distinction between mosquito control for public health protection, and mosquito control for the relief of human discomfort (sometimes called nuisance control). Nearly all human biting mosquitoes in Suffolk County have some vector capability for the arboviruses that are the modern day health threats in the northeast US. In almost all instances, control of these human biting mosquitoes therefore has some impact on the overall risk of disease. Actions taken to reduce the populations of human biting mosquitoes in Suffolk County reduce the risk of disease transmission, and result in a public health benefit beyond minimization of subclinical effects. In addition, there is a significant improvement in the quality of life for those who live, work, or recreate where these mosquitoes live, when mosquito numbers are reduced. In many instances, especially along the south shore of the County, mosquito control is conducted to provide relief from the persistent and oft-times unbearable impacts of numerous aggressive mosquitoes seeking mammalian blood meals. These control efforts also clearly limit the transmission risks for mosquito-borne disease.

State and County Public Health Law (PHL) identify mosquito control and the reduction of mosquito habitat (such as standing water) as abatement of public nuisance. A public health nuisance is a condition which affects public health, and in this case it is the recognition of health effects from an ectoparasite (mosquitoes are grouped as such with pests such as lice, fleas, and bedbugs). Under State law, health officers have a duty to address the effects caused by these to the public. The presence of pathogens in mosquitoes is not required for this definition of public health nuisance, as the law implicitly recognizes there are health concerns that extend beyond the transmission of diseases such as WNV and EEE.

In summary, there are impacts to the quality of life from large numbers of aggressive biting mosquitoes. Many areas of the country are renowned for their uncomfortable insect problems. Suffolk County, especially along its shorelines, can be infested by large broods of *Ochlerotatus sollicitans*, the salt marsh mosquito. This species of mosquito is especially aggressive in its feeding on mammals, especially people. It is an opportunistic feeder, and although it prefers to

seek hosts around dawn and dusk (crepuscular activity), it is one of the very few mosquitoes that will leave daytime resting places when disturbed to seek a blood meal. This means walking across a lawn in the summer sun when a brood is present can result in many bites in a very short period of time. This species' eggs need to dry for several days after being laid, and only hatch in water; therefore, higher lunar or storm tides trigger broods which hatch, develop, and mature at approximately the same time. This means that millions of mosquitoes can leave a particular marsh at the same time, all seeking hosts to provide necessary blood meals, as the generation of eggs requires this input of proteins.

Prior to organized mosquito control, large areas of the coastal northeast US were considered to be mostly uninhabitable. The large-scale distribution of screens and the invention of air conditioning mean that the absence of control of salt marsh mosquitoes might not lead to abandonment of these now densely populated areas. Broods of *Oc. sollicitans* can make some of the most ordinary of suburban activities, such as mowing a lawn, playing in the yard, or even walking to the car, subject to extreme discomfort. This leads to undeniable losses in quality of life for what can sometimes be extensive periods of time. Suffolk County thus recognizes that mosquito control has important ancillary quality of life benefits.

Modern vector control efforts also have a focus on reducing impacts associated with controlling mosquitoes. The County will seek to implement progressive means of water management that will enable it to significantly reduce the application events as well as the overall amounts of and areas affected by larvicides. This greater degree of control is anticipated to reduce the places, application events, and overall amounts of and areas affected by adulticide used in the County. However, decisions to use adulticide are not necessarily determined by the number of mosquitoes; adulticides are often used to reduce any explicit health threat the mosquitoes may represent.

The pesticides considered for use by the County today for mosquito control have been shown to have little to no health effect on humans, even when exposures are projected for entire lifetimes. At the concentrations that they are applied at, according to most scientific investigations, the formulations have no acute effects on humans, chronic effects are generally found to be of little concern, and the risk of cancer has been judged not to have been substantiated by laboratory

studies. This is because these chemicals are designed to affect insects, especially mosquitoes, not humans. Most are applied at low concentrations due to the relative fragility of the mosquito (compared to other, agricultural pests that typically require much higher concentrations to be controlled). These pesticides are made to degrade quickly in the environment, so that the amount any person is exposed to, and the time period that an application can affect people, are both extremely small. These same traits limit impacts to non-target organisms present in the environment. Modeling shows that there is a small risk from some adulticides to specific organisms, such as insects flying when the application occurs, and certain invertebrates in exposed aquatic habitats. However, modeling of ecological impact (and similar monitoring efforts) have found no long-term impacts to the ecosystem. In addition, measurements of actual pesticide concentrations following applications in Suffolk County show that modeling may use unduly conservative assumptions regarding the pesticides' environmental persistence, and so there may actually be no measurable impacts to the environment associated with the use of most modern mosquito control pesticides.

Progressive vector control practices can even restore degraded or threatened wetlands, and so produce environmental improvements. Careful, scientific selection of appropriate water management techniques will result in healthier marshes County-wide, resulting in greater ecological diversity and productivity for our precious salt marshes and the estuarine systems associated with them. Suffolk County is embedded in the marine environment, and the waters that surround us are cherished and important to us all. Improvements to water management procedures for mosquito control will lead to measurable enhancements of these natural resources. With cooperation from other local marsh managers and regulators, the County anticipates restoring more than one third of the marshes in the County over the next ten years. The effect will not only be less pesticide use in these marshes, but also improved ecological functioning of the restored areas.

### 1.3 Objectives

Explicating a set of well-defined objectives for the Long-Term Plan provides the means for the interested public to understand how the ambitious Goals of the Long-Term Plan will be achieved. The following are the objectives for the two goals.

**Goal 1: Decrease risks to human health and impacts to public welfare from mosquitoes and mosquito management**

Objective 1. The prevention of serious disease in residents of and visitors to the County, as practical, is of utmost importance.

Objective 2. Enhancement of public welfare, including the reduction of non-disease impacts to the quality of life where severely impacted by pestiferous mosquitoes, is also important.

Objective 3. Generally, problem populations of mosquitoes will be reduced where possible, both to reduce impacts to human welfare but also because large numbers of human-biting mosquitoes, in association with people and areas where mosquito-borne diseases have been detected, represent increases in overall health risks for those people.

Objective 4. To achieve these objectives, the County's program will follow the principles of IPM, seeking to address mosquito problems by means of appropriate controls applied at times of greatest effectiveness and least impact to human health and the environment.

Objective 5. A program of scientific surveillance will be employed, with the intent of accurately and specifically defining potential mosquito problems.

Objective 6. Source reduction will be the primary focus of mosquito control. A key element will be public education, outreach, and assistance for habitat reduction around homes and businesses. The second key element is the adoption of a progressive and extensive water management program, to be implemented in coordination with local and State agencies and with the participation of other interested parties.

Objective 7. The use of biorational larvicides, specifically targeted towards the insects of concern, will allow for reduction of any identified mosquito problem prior to dispersal as adults, when control is more difficult.

Objective 8. The use of adulticides, when all other methods of control have been unsuccessful or when other control methods cannot be implemented, will be undertaken so long as the adulticide poses no significant risk to human health.

Objective 9. The mosquito control program in general will be guided by an appreciation for the overall management of risk to people, minimizing potential impacts to human health from disease and from control methods.

Ancillary objectives of the Long-Term Plan are to facilitate enjoyment of the County's natural environments, and to support local businesses and enterprises that depend on tourism and recreation, as is possible while also attaining the specified objectives of the Plan.

**Goal 2: Simultaneously reduce impacts to the environment and increase potential ecological benefits associated with the selected management techniques.**

Objective 1. The County will adopt a progressive plan for marsh management that will emphasize the need to preserve or increase acreage of wetlands, including vegetated wetlands, and to foster biodiversity and a mosaic of ecological communities. In salt marshes, this will lead to overall habitat diversity, generated by an ecological setting composed of tidal creeks, ponds, low and high marsh, pannes, mudflats, salt shrub, associated freshwater wetlands, and adjacent beaches or sand berms (although every marsh may not have all habitats). This will provide a variety of microhabitats and ecotones, which should support appropriate plant and animal diversity, as measured by monitoring and project evaluations. Projects conducted under the Long-Term Plan will also seek to reduce invasive species, especially *Phragmites*, in the managed wetlands.

Objective 2. The intent of the water management program will be to reduce the routine use of larvicides, ultimately resulting in significant reductions in the overall acreage where larvicides are applied each year. The priority salt marshes for progressive water management will be those where aerial applications of larvicide are required to treat mosquito breeding.

Objective 3. Where mosquito breeding occurs despite water management efforts, or where no such actions can be taken, biorational larvicides will be used to ensure that no (or, at worst, minimal) non-target impacts to the surrounding ecosystems.

Objective 4. If adult mosquito population control is necessary, the County will use adulticide products that have no significant, long-term impacts to the environment.

Objective 5. The mosquito control program in general will be guided by an appreciation for the overall management of risk, minimizing potential impacts to the environment and natural systems and improving them where possible, while protecting human health and public welfare.

## 1.4 Mosquitoes of Suffolk County

Table 1 lists the 50 mosquito species found in Suffolk County. This list has been compiled through trapping and literature analyses by the Suffolk County Department of Health Services (SCDHS) Arthropod-Borne Disease Laboratory (ABDL), Dr. Scott Campbell, Director.

Table 1. Mosquitoes of Suffolk County

| | **Reinert (2000)** | **WRBU (2005)** |
|---|---|---|
| 1 | *Aedes cinereus* | *Aedes cinereus* |
| 2 | *Aedes vexans* | *Aedes vexans* |
| 3 | *Anopheles barberi* | *Anopheles barberi* |
| 4 | *Anopheles bradleyi* | *Anopheles bradleyi* |
| 5 | *Anopheles crucians* | *Anopheles crucians* |
| 6 | *Anopheles earlei* | *Anopheles earlei* |
| 7 | *Anopheles punctipennis* | *Anopheles punctipennis* |
| 8 | *Anopheles quadrimaculatus* | *Anopheles quadrimaculatus* |
| 9 | *Anopheles walkeri* | *Anopheles walkeri* |
| 10 | *Coquillettidia perturbans* | *Coquillettidia perturbans* |
| 11 | *Culex erraticus* | *Culex erraticus* |
| 12 | *Culex pipiens* | *Culex pipiens* |
| 13 | *Culex restuans* | *Culex resturans* |
| 14 | *Culex salinarius* | *Culex salinarius* |
| 15 | *Culex territans* | *Culex territans* |
| 16 | *Culiseta annulata* | *Culiseta annulata* |
| 17 | *Culiseta inornata* | *Culiseta inornata* |
| 18 | *Culiseta melanura* | *Culiseta melanura* |
| 19 | *Culiseta morsitans* | *Culiseta morsitans* |
| 20 | *Culiseta silvestri minnesotae* | *Culiseta silvestri minnesotae* |
| 21 | *Ochlerotatus abserratus* | *Aedes abserratus* |
| 22 | *Ochlerotatus atropalpus* | *Aedes atropalpus* |
| 23 | *Ochlerotatus aurifer* | *Aedes aurifer* |
| 24 | *Ochlerotatus canadensis* | *Aedes canadensis* |
| 25 | *Ochlerotatus cantator* | *Aedes cantator* |
| 26 | *Ochlerotatus diantaeus* | *Aedes diantaeus* |
| 27 | *Ochlerotatus dorsalis* | *Aedes dorsalis* |
| 28 | *Ochlerotatus excrucians* | *Aedes excrucians* |
| 29 | *Ochlerotatus fitchii* | *Aedes fitchii* |
| 30 | *Ochlerotatus flavescens* | *Aedes flavescens* |
| 31 | *Ochlerotatus grossbecki* | *Aedes grossbecki* |
| 32 | *Ochlerotatus hendersoni* | *Aedes hendersoni* |
| 33 | *Ochlerotatus intrudens* | *Aedes intrudens* |
| 34 | *Ochlerotatus japonicus japonicus* | *Aedes japonicus japonicus* |
| 35 | *Ochlerotatus sollicitans* | *Aedes sollicitans* |
| 36 | *Ochlerotatus sticticus* | *Aedes sticticus* |
| 37 | *Ochlerotatus stimulans* | *Aedes stimulans* |
| 38 | *Ochlerotatus taeniorhynchus* | *Aedes taeniorhynchus* |
| 39 | *Ochlerotatus triseriatus* | *Aedes triseriatus* |
| 40 | *Ochlerotatus trivittatus* | *Aedes trivittatus* |
| 41 | *Orthopodomyia alba* | *Orthopodomyia alba* |
| 42 | *Orthopodomyia signifera* | *Orthopodomyia signifera* |
| 43 | *Psorophora ciliate* | *Psorophora ciliata* |
| 44 | *Psorophora columbiae* | *Psorophora columbiae* |
| 45 | *Psorophora confinnis* | *Psorophora confinnis* |
| 46 | *Psorophora ferox* | *Psorophora ferox* |
| 47 | *Psorophora howardii* | *Psorophora howardii* |
| 48 | *Toxorhynchites rutilus septentrionalis* | *Toxorhynchites rutilus septentrionalis* |
| 49 | *Uranotaenia sapphirina* | *Uranotaenia sapphirina* |
| 50 | *Wyeomyia smithii* | *Wyeomyia smithii* |

Reinert, JF. 2000. New classification of the composite genus *Aedes* (Diptera: Culicidae: Aedini), elevation of subgenus *Ochlerotatus* to generic rank, reclassification of the other subgenera and notes on certain subgenera and species. *Journal of the American Mosquito Control Association* 16:175-188.

WRBU. 2005. *2001 Systematic Catalog of Culicidae*. Walter Reed Biosystematics Unit. www.mosquitocatalog.org/main.asp. Retrieved June, 2005.

Not all of the mosquitoes on the list are of concern for people. Mosquitoes that do not impact people either through biting or disease association are sometimes labeled as scientific curiosities. However, even these mosquitoes can become of interest as conditions change. *Culiseta melanura* was once treated as a curiosity because of its strange overwintering habitat in the roots of trees in swamps. Currently, this mosquito is subjected to intense surveillance, as it plays an essential role in the amplification of EEE.

Table 2 contains the list of 15 species of concern in the County. The mosquitoes have been classified in terms of their vector capability and/or impacts to quality of life. It is clear that it is difficult to separate the mosquitoes that serve as disease risks from those that are of concern for the spread of disease. This is partially because aggressive biting behavior is a characteristic that is likely to make a mosquito species a bridge vector, especially since birds constitute the major disease hosts for arboviruses. Mosquitoes that are aggressive also tend to be somewhat indiscriminant in their feeding habits, and so create opportunities, if they are capable of serving as a vector for a disease, of spreading that disease from birds to people due to their feeding habits.

Table 2. Mosquito Species of Concern in Suffolk County

| Species | Vector Status | Human Nuisance |
|---|---|---|
| *Aedes vexans* | Known WNV bridge vector<br>Probable EEE bridge vector | Aggressive, SC's major fresh flood water mosquito |
| *Anopheles punctipennis* | Possible WNV bridge vector | Pesky, enters houses |
| *Anopheles quadrimaculatus* | Malaria vector | Moderately aggressive |
| *Coquillettidia perturbans* | WNV and EEE bridge vector | Aggressive nuisance, breeds in emergent fresh marshes |
| *Culex pipiens* | WNV amplification vector<br>Probable WNV bridge vector | Breeds near (containers, catch basins, other standing water) and enters houses |
| *Culex restuans* | WNV amplification vector | |
| *Culex salinarius* | WNV bridge vector | Irritating biter, breeds in brackish flood water (rare in SC) |
| *Culiseta melanura* | EEE amplification vector<br>Probable WNV amplification vector | |
| *Ochlerotatus canadensis* | Probable EEE bridge vector<br>Possible WNV bridge vector | Spring fresh water mosquito, extremely long lived, avid human biter |
| *Ochlerotatus cantator* | Possible WNV bridge vector | Spring salt water mosquito, moderately aggressive |
| *Ochlerotatus japonicus japonicus* | WNV bridge vector | Tree-hole (tire) mosquito, causes local nuisance, moderately aggressive |
| *Ochlerotatus sollicitans* | EEE bridge vector<br>Probable WNV bridge vector | SC primary pest species, extremely aggressive, salt water flood mosquito |
| *Ochlerotatus taeniorhynchus* | Possible WNV bridge vector | Aggressive salt water flood mosquito |
| *Ochlerotatus triseriatus* | Possible WNV vector<br>LaCrosse encephalitis vector | Irritating pest, containers-tree holes-tires mosquito |
| *Ochlerotatus trivittatus* | Possible WNV vector | Aggressive fresh flood water (recharge basins) mosquito |

## 1.5 Environmental Settings of Concern

Mosquitoes are aquatic through their larval stages. All mosquitoes need water in order to survive. The additional requirements of their larval life-style mean that the salt marshes and fresh water wetlands of Suffolk County are of special concern as potential environments for mosquito breeding. Cashin Associates quantified 16,839 acres of vegetated salt marsh within the County through a GIS mapping interpretation. The New York State Department of Environmental Conservation (NYSDEC) has mapped 18,084 acres of fresh water wetlands. SCVC has established over 2,000 "breeding points" to monitor on a regular basis for potential control of mosquitoes. However, there are an estimated 100,000 storm water structures along roads in the County, and innumerable half-filled cans, wading pools, poorly-maintained gutters,

and abandoned swimming pools, plus thousands of discarded tires, in backyards and throughout the woods, all of which can also serve as sites to breed mosquitoes. Sites as small as a deer hoofprint or as large as 500 acres of salt marsh can serve as focus points for a breeding problem, which makes for a daunting scope of work.

### 1.6 Legal Authority for Mosquito Management

New York State PHL authorizes agencies to investigate and ascertain the existence and causes of disease outbreaks, including vectors, and to take measures necessary to protect the public health. The New York State Department of Health (NYSDOH) enforces compliance with the PHL. The powers and duties of NYSDOH are set forth in Article 2, § 201 of the PHL. Among these are the supervision of local boards of health and health officers, (PHL § 201[a]), supervision of the reporting and control of disease (PHL § 201[c]), controlling the pollution of waters of the state (PHL § 201[l]), controlling and supervising the abatement of nuisances likely to affect public health (PHL § 201[n]), and advising any local unit of government in the performance of their duties and regulate financial assistance granted by the state in connection with public health activities (PHL § 201[o]).

PHL Article 15, sections 1520 et seq., authorizes a county to form a Mosquito Control Commission (MCC), and sets forth the powers and duties of said commission. The commission may use appropriate means to suppress mosquitoes, with the limitation that said measures "shall not be injurious to wildlife" (PHL sec. 1525[2]). In Suffolk County, mosquito control was a function of the Suffolk County MCC. That Commission is still referenced in the Suffolk County Charter (SCC), but is no longer active. Amendments to the County Charter in 1973 established the SCDHS. These amendments continued the existence of the Suffolk County Health District, noting therein that the Commissioner of the Department would be the chief administrative officer of the District, and that any reference of the New York State PHL to a local commissioner of health and/or a local department of health would be deemed to refer to the newly formed Department or its Commissioner, as appropriate. The Commissioner was to be a County Health Commissioner within the meaning of Article 3, Title III, of the PHL (SCC § C9-1, § C9-2; L.L No. 25 of 1973). Subsequently, vector control activities were the responsibility of the Division of Public Health in SCDHS.

However, in 1992, amendments to Sections C8-2 and C8-4 of the SCC established the SCVC as part of the Suffolk County Department of Public Works (SCDPW) and authorized the Division to "use every means feasible and practical" to suppress mosquitoes and other arthropods (SCC § C8-2, § C8-4; L.L. No. 16 of 1992). That Local Law also noted as follows:

"(A)lthough the authority for the county to establish a vector control program is contained within the New York State PHL, this law does not mandate that vector control activities be performed under the auspices of the local Health Department. However, in the event that an arthropod-borne disease is found to constitute a major public health threat, the DHS shall directly supervise vector control" (L.L. No. 16 of 1992, Section1).

SCVC is responsible for controlling mosquito infestations that are of public health importance, pursuant to the powers granted to the County under the PHL. In the event of a vector control emergency, "as defined" by the Commissioner of Health Services, the direct supervision of vector control shall be by the DHS (SCC § C8-2[Y], L.L. No. 16 of 1992).

The SCDHS is responsible for monitoring and prevention of human diseases, including those borne by mosquitoes such as WNV and EEE. The Department monitors the blood supply, handles reports of WNV and EEE infected birds and horses, and responds to health emergencies through its Division of Public Health. In the event that an arthropod-borne disease is found to constitute a major public health threat, the vector control program would be under the control of the DHS (SCC, § C8-2[y], L. L. No. 16 of 1992). SCDHS, Division of Environmental Quality, through its Office of Ecology, manages a number of water quality and restoration programs that involve wetlands managed by the Division of Vector Control. The Office of Ecology is the program director for the Peconic Estuary Program, and is the major County participant in the South Shore Estuary Reserve and the Long Island Sound Study.

According to the SCC, SCVC shall have

> "charge and supervision for vector control throughout the County of Suffolk. The Department shall have the power and authority to enter without hindrance upon any or all lands within the county for the purpose of performing acts which in its opinion are necessary and proper for the elimination of mosquitoes and other arthropods, provided that such measures are not injurious to wildlife. In the event of a vector control emergency, as defined by the Commissioner of Health

> Services, the direct supervision of the vector control shall be by the Department of Health Services." (SCC § C8-2(Y).

The charter also specifies the powers of SCVC, and relates its responsibilities. The Division of Vector Control

> shall use every means feasible and practical to suppress mosquitoes, ticks and other arthropods which are vectors of human disease requiring public action for their control. In carrying out its responsibility hereunder, the Division shall have the power and authority to enter without hindrance upon any or all lands within the county for the purpose of draining or treating the same and to perform all other acts which, in its opinion and judgment, may be necessary and proper for the elimination of mosquitoes and other arthropods, but such measures shall not be injurious to wildlife (SCC § C8-4(B) (1))

The responsibilities listed for SCVC include submitting an Annual Plan of Work to the Legislature each year, and various public noticing requirements. These include different kinds of notices for truck and aerial applications, and also for when there has been a declared health emergency, and when there is not such an emergency.

# 2 Public Education and Outreach

Responsible mosquito management, conducted according to IPM, involves a hierarchical approach to identifying and addressing problems. The hierarchy is:

- Scientific surveillance
- Source reduction (including water management)
- Larval control
- Adult controls

The use of biological controls (biocontrols) is usually an important element. A key area tying together all of these facets of mosquito management is public education and outreach. In a sense, public education is part of the control hierarchy, as an educated public can take steps to eliminate mosquito breeding areas around the home and protect themselves effectively from mosquito bites and the effects associated with the bites. However, nowhere has it been possible to achieve compliance rates for personal protection so as to eliminate the need for organized vector control to ensure public health and welfare.

## 2.1 Public Education

Public education is a key element of the Management Plan. Public education can:

- help people avoid mosquitoes and mosquito-borne disease
- raise public awareness of the value of good housekeeping
- ensure the public cooperation essential for Vector Control's operation
- provide justification for the actions taken by the County on behalf of its citizenry to control mosquitoes and mosquito-borne disease, and,
- avoid public demand for more pesticide applications than are truly necessary, out of excessive concern over mosquito-borne disease.

SCDHS is primarily responsible for public education on mosquitoes and mosquito-borne disease. It has greatly expanded its role in educating the public about the public health importance of mosquitoes and in developing the means to keep the public informed, should control measures be necessary.

WNV vectors such as *Culex pipiens* and *Ochlerotatus japonicus* often breed in artificial containers, clogged rain gutters, birdbaths, and other inaccessible places found around the house. *Cx. pipiens*, in particular, prefers polluted water for breeding. This means that maintaining items such as birdbaths, or emptying containers in the yard, can have substantial impacts on risks associated with disease transmission. The County will promote information on personal protection and avoidance by distributing brochures and giving presentations on its "Dump the Water" and "Fight the Bite" programs. Additionally, the Long-Term Plan Citizens Advisory Committee created a new pamphlet titled, "Mosquito Control and Prevention at Home" that it will distribute to libraries and at health fairs.

SCDHS began its annual Dump the Water Campaign in 2000. It was created by legislation, through the Suffolk County Legislature. Every year in January, elementary students in Suffolk County participate in a poster contest hosted by the members of the Legislature. The winning poster is used as the cover for the Dump the Water public education pamphlet. The Dump the Water pamphlet includes information on how WNV is transmitted and what the public can do to eliminate mosquito-breeding sites around their homes. The pamphlet encourages the public to educate their neighbors and local business owners, in addition to getting involved in organizations that participate in clean-up drives. It also lists contact numbers and website addresses for SCDHS, SCVC, and NYSDOH for further information.

The "Fight the Bite" pamphlet includes information on:

- facts about mosquito species
- where they live and breed
- symptoms of WNV
- who is most at risk of contracting WNV

- when mosquitoes are most active

- what can be done around the house to diminish mosquito-breeding sites

An illustration is included to demonstrate where typical mosquito breeding sites can be found around the home. The brochure also provides examples on what to do to protect oneself from mosquitoes, how to properly use products containing the mosquito repellant DEET, and what to do after spotting a dead crow. As with the SCDHS brochure, the New York State publication also includes contact information, although this information is for statewide offices concerned with mosquito control.

In addition to the SCDHS efforts, SCVC offers public assistance to help homeowners who have mosquito problems, by visiting the property and removing breeding areas. If the homeowner is not available during the site inspection, SCVC ground crews hang tags on the front door knob. The door hanger describes the reason for the inspection and lists any work done. It also provides basic information about mosquito control. The tag gives contact telephone numbers, and directs the homeowner to the SCVC website for more information.

Each year during the off-season, prior to the development of the coming year's brochure, field personnel from SCVC should interact with the health educators from SCDHS. This will allow transfer of information from the field to the educators regarding the kinds of persistent problems that are not being reduced through current education programs. In addition, field crews will be made aware of the current focus and ranges of materials used by the educators, which should enhance the field crews' education efforts, as well.

Another way in which SCDHS could improve public outreach is to participate in "Mosquito Awareness Week", which is an American Mosquito Control Association (AMCA) sponsored program that takes place at the start of the summer season. This program provides mosquito control professionals with a time frame that can be devoted to focusing the public's attention on the services SCVC provides. An electronic flyer is sent to AMCA members and mosquito control supervisors. The flyer includes a template for press releases to local newspapers, along with ideas for content. It also offers suggestions on ways to distribute mosquito control information to various media outlets, such as serving as a guest expert on a local radio show.

Mosquito control supervisors are reminded to have technicians mention and emphasize the positive changes and environmentally friendly methods used in mosquito control.

Since the County's human population is becoming more diverse, publications in upcoming years may wish to draw upon New York City's experience and capabilities for outreach to immigrant groups. The New York program produced outreach materials in 17 languages; this available material may decrease the learning curve should the County determine that other languages, such as Spanish, need to be added to its educational arsenal.

This educational program should be expanded to include a tire disposal component. Outside review of the existing County program found the lack of a tire management component to be a major deficit. Tires are a major breeding opportunity for mosquitoes because they retain water so well. The mosquito that breeds most readily in tires, *Oc. japonicus*, has also been identified as a major relative risk factor for WNV, despite its relatively low numbers in the County, because it is a very efficient vector of WNV. It has the great potential to transmit the disease to people should it become infected, due to its propensity for feeding on mammals. The County should undertake an education program to persuade citizens not to inappropriately discard tires, but to manage them properly. Tires should not be stored out of doors. The County should conduct internal outreach so that Departments such as Parks and Public Works, in the course of other maintenance activities, understand the importance of removing littered tires when encountered. Although the Towns are the level of government responsible for zoning and waste management in the County, the County should determine if it can provide useful resources to allow Towns to address tire stockpile issues. One notorious stockpile is in Smithtown (Old Northport Road), where millions of tires were buried to reduce risks associated with fire. This also eliminates mosquito habitat, but unless this site and others like it are monitored and managed, they hold the potential of becoming serious health risk loci.

Water use issues in farm areas are often of concern, especially on the East End where water quantity may become a more pressing issue as populations rise. Irrigation can cause ponding on fields which generates mosquito breeding habitat. SCVC already maintains certain water management structures in agricultural areas to drain standing water. Targeted education through

Cornell Cooperative extension can reach this audience efficiently, and reinforce the already delivered message regarding best practices for irrigation conditions.

Another missing element in the current County outreach program is something undertaken in Westchester County. This is targeted outreach to commercial property owners and private homeowner associations to ensure that private storm water systems are properly maintained. In this instance, a well-worded insert in tax bills (or separate mailing utilizing County property data bases), identifying benefits to the County that include decreased flood impacts, improved public health, and avoidance of a label as a public health nuisance, may encourage neglected maintenance to be undertaken.

Similarly, SCVC, through SCDPW, needs to raise awareness in the County and in other municipal highway offices, that poor maintenance of catch basins and other storm water systems not only exacerbates flooding problems and is not in compliance with United States Environmental Protection Agency (USEPA) Phase II regulations, but threatens public health. These underground facilities are prime *Cx. pipiens* habitat. Although it is uncertain how much WNV is actually transmitted by *Cx. pipiens*, several cases of WNV in the County have occurred where trapping has found *Cx pipiens* almost exclusively. It is clearly the prime amplification vector for the disease. Any reduction in the numbers and range of this mosquito, which tends not to fly too far from its habitat, has immediate implications for the risks faced by people in the immediate vicinity of the structure that has been maintained.

The County websites for SCVC and SCDHS provide current information about upcoming spray events and general work of SCVC, and information about what the public can do for protection from mosquitoes, and to help combat mosquitoes around their homes. The website also describes the various methods and products used by SCVC for mosquito control. Information regarding the dates and events taking place during "Mosquito Awareness Week" will also be made available on the SCDHS website with links to each of the brochures the used in the public education program.

Another recommendation for public outreach is to post efficacy reports on the SCVC website at the beginning, middle and end of the season. These reports will summarize the results of mosquito control efforts that were measured before, during and after aerial spray events.

Reporting efficacy to the public will emphasize how SCVC operations are improving the quality of life in their community and throughout Suffolk County. Public support for vector control operations will aid the County in justifying the need for the formation of the new Mosquito Surveillance and Control unit, which will perform quality assurance and quality control functions.

## 2.2 No-Spray Registry

Suffolk County adopted a law in 2001 which resulted in the creation of the "no-spray registry". The law requires SCVC to "make a good faith effort" to exclude each property by stopping adulticide spraying from trucks within 150 feet on either side of the registrant's property. Operationally, this translates to sprayers being shut off on the street in front of the registered property and 150 feet on either side of the property. SCVC maintains a "no-spray" registry of residences where adult mosquito control is not desired. Citizens can sign up for this registry via the SCDPW website, or by calling the SCVC directly. This registry represents an effort to balance the desires of those residents who want control of adult mosquitoes with those who are more concerned about the potential effects of pesticides, however small the risk. In 2005, a little less than 900 properties were registered. Many of these, as it happens, are located in areas where serious infestations were rare. For this reason, the registry has thus far had little effect on control operations. It is recommended that the registry's existence be included in public education presentations and printed in educational brochures. This will allow residents without Internet access to join the list, if desired.

When control is required to deal with a public health emergency, the Commissioner of Health Services can override the list. Even then, efforts are made to telephone list members prior to applications in their area.

In addition to this legally required registry, the SCVC maintains special listings of beekeepers and organic farms. Beekeepers are generally avoided or notified before treatments so that they can protect their hives. Because the commonly used SCVC adulticides are not registered for croplands, organic farms and all other croplands are excluded from spray areas to ensure label compliance. Organic farms are specially called out because many are small and in otherwise residential areas.

## 2.3 Notification

In 2000, the County passed new laws to improve required public notification for adult mosquito control. As a result, there is now an increased use of the media and extensive outreach to local officials when any such actions are considered. The SCDHS web site is used to post maps and will be used to post spray schedules. In addition, a list serve feature will be installed on the SCDHS website to allow citizens the choice to automatically be informed of spray events. For each adulticide application, over 150 faxes are sent to various officials and other interested parties. Newsday and News12 post spray schedules and maps and "No Spray" members are telephoned. Notifications are also broadcast over several local radio stations, posted on a call-in hotline, and on orange signs at the entrance of parks where applications are scheduled. The Suffolk County Board of Cooperative Educational Services (BOCES) is also notified, and it, in turn, notifies schools.

It is important to recognize that adulticide applications have well-defined acceptable weather conditions. The need to inform the public will need to be balanced with the need to conduct operations promptly, within weather windows and before the problem spreads and more acreage may need treatment. It is not appropriate to provide more than 24 hours notice in most cases, because beyond that time, weather forecasts do not have the necessary reliability to schedule the application events. Attempts to provide more than 24-hour notice can result in many spray operations being announced but then cancelled, which can be very confusing to the public.

In addition to these formal outreach operations, the Long-Term Plan envisions continuing its Citizens Advisory Committee as a means of having on-going dialog with involved members of the public. This Committee has served an important role in the course of developing the Plan, and has routed useful and important information and viewpoints to planners and researchers.

SCVC has also had the opportunity to renew contacts with members of various state, federal, and local agencies and governments, and certain interested non-governmental organizations, through the Long-Term Plan. The Wetlands Advisory Committee has been a key venue for these efforts. The Long-Term Plan requires that similar kinds of communications continue in order to achieve important aspects of the proposed Plan.

## 2.4 Website

Information on WNV, the Long-Term Plan process, pesticide application notification and a "No Spray" registry are included on the County mosquito control website. However, only the pesticide spray schedule and "No Spray" registry are regularly updated. Annual reports from SCDHS are also available on the website. These reports are not current and focus on SCDHS operations, such as Emergency Medical Services and Mental Health Services, versus vector control program information. Both deficiencies stem from resource allocation limitations.

The website needs to be updated, and a means of regularly posting new and relevant information there must be established. The results of efficacy testing, for example, and the various annual and other reports that will be produced on a regular basis as a result of the Plan should be made available to the public.

# 3. Surveillance

## 3.1 Background

The goals of a sound surveillance program are to monitor the distribution and abundance of larval and adult mosquitoes and the prevalence of mosquito-borne diseases. This is accomplished by a variety of mechanisms, including trapping mosquitoes, monitoring their breeding, analyzing them for evidence of viral activity, and monitoring other species that may have become infected by mosquito-borne disease. Results from monitoring are used in progressive mosquito control efforts to determine appropriate interventions in order to reduce impacts to human health and public welfare, minimizing the risks associated with the intervention chosen. Sufficient monitoring efforts lead to an adaptive response program, as interventions can be tailored to achieve the desired impact on the targeted mosquito populations — that is to say, effective monitoring leads to gauging the effect of interventions, and so tuning the level of intervention to meet changing conditions.

Larval surveys can determine the location, species, and population densities of mosquito larvae for predictions of adult emergence and for gauging required control measures. They are also utilized to assess the effectiveness of larval control measures. This requires examining aquatic habitats for the presence of the larvae, and colleting samples for specification (in the field or back at a laboratory).

The three most commonly used adult mosquito traps are the New Jersey light trap, the CDC light trap, and the CDC gravid trap. The New Jersey light trap attracts a variety of mosquito species and is especially useful for monitoring long-term changes in adult mosquito population density and species composition. Because the New Jersey light trap kills mosquitoes, it cannot be used to monitor virus activity. Some species of interest are not attracted to this type of light trap. Human biters (including *Ochlerotatus sollicitans* and *Culex* spp.) are sampled with CDC traps to provide additional viral surveillance. CDC light traps utilize $CO_2$ as an attractant. Gravid traps are used to sample for egg-bearing (gravid) *Culex spp*. mosquitoes, which carry WNV. Gravid traps utilize what is described as "polluted" water (organic water, often with odors, to attract *Cx. pipiens*). Both kinds of CDC traps provide live mosquitoes suitable for viral assay.

Another critical component of a sound monitoring program for the Long Island region is surveillance for the presence of EEE and WNV. CDC light and gravid traps are used at locations chosen for their history of viral activity to trap the mosquito vectors of these diseases.

Disease surveillance also includes reports from veterinarians and doctors regarding disease outbreaks. Because birds are intimately involved in many arbovirus transmission cycles, testing of dead or captured wild birds and monitoring of sentinel domestic flocks is also widely used to determine if viruses are becoming a human health concern.

Surveillance is intended, according to guidance from both the Center for Disease Control and Prevention (CDC) and NYSDOH, to provide local officials with appropriate information to make informed decisions regarding disease risk. This information is essential in order that responses to risks are consistent to the level of health threat posed by the mosquito populations. These guidelines describe increasing degrees of surveillance and control as the risk of disease transmission increases.

### 3.2 Larval Mosquito Populations

Larval surveillance provides information on expected adult mosquito density and areas where source elimination or larvicide efforts should be targeted. Teams of inspectors, consisting of three foremen with 11 field crews that each consist of two equipment operators or laborers, will continue to be assigned to geographic areas of the County to guarantee complete coverage of potential breeding habitats on a regular basis. The number of field crews assigned to each geographic area is dependent upon the number of wetlands located within each area. The names of the geographic areas and the number of field crews assigned to each area are listed in Table 3. These areas are designated as:

- south shore west, which includes Babylon, Islip, and southwestern Brookhaven.
- south shore east, which includes southeastern Brookhaven, Southampton, and East Hampton.
- north shore west, which covers Huntington and Smithtown.

- north shore east, which includes northern Brookhaven, Riverhead, and Southhold. Inspectors from the north shore west areas also assist with surveying salt marshes in south shore west areas (such as Gardiner's Park and Heckscher State Park).

Table 3. Geographic designations for larval surveillance and the number of field crews per area.

| Geographic Area | # of field crews |
|---|---|
| south shore west | 3 |
| south shore east | 4 |
| north shore west | 2 |
| north shore east | 2 |

Inspectors obtain samples from larval breeding areas, such as wetlands, primarily using a technique known as dipping. Dipping is performed using a cup on a long dowel handle to collect a small amount of water. The presence of mosquito larvae in the water indicates breeding activity. Inspectors will quantify larval surveillance results in the field by counting the number of larvae per dip. They will also determine which of four larval stages are present. At times, other sampling methods will need to be employed to determine if specific species are present. Tires, for instance, are often sampled using aspirators. Various means of pulling water out of cavities are used to sample in tree crypts for *Cs. melanura*. *Coquilletidia perturbans* larvae attach themselves to underwater plants, and need to be pulled from this attachment. Catch basin sampling has led to specialized equipment. In this case, aquarium nets are attached to telescoping poles, and then the nets are rinsed to wash the larvae into a bucket for further processing.

SCVC has identified over 2,000 breeding points throughout the County. These are areas where problem mosquito populations have re-occurred. The sites range from small, intermittent freshwater wetlands to salt marshes that can be several hundred acres in size. Each breeding location has been assigned a unique identifier, composed of letters (for the Town) and numbers (so that BH-112 would be in Brookhaven). Each sampling point has also been mapped using GPS, and to further encourage consistent sampling, it tends to be monitored by the same inspector team.

Breeding locations are monitored on different schedules according to the type of mosquito problem that is usually associated with the particular site. The highest priority surveillance

locations are the salt marshes that are candidates for aerial larviciding. These marshes are monitored every Monday for breeding activities. Additional monitoring can be required if environmental conditions (unusually high tides or heavy rainfall) suggest that mosquitoes may hatch after Monday and temperatures indicate they will develop quickly. Then inspectors may be requested to revisit the sites later in the week.

Each field crew also is assigned a route of smaller salt marshes and fresh water sites that also tend to breed fairly regularly. These sites are monitored on a 10 day to two week cycle. SCVC supervisors may authorize overtime to ensure routes are completely monitored more expeditiously if environmental conditions (again, higher tides or heavy rainfalls) indicate that breeding is more likely to be occurring.

Finally, there are certain locations that only support breeding under particular environmental conditions. The field crews develop experience regarding some of these locations, and only visit them when the requisite trigger has occurred. These may be breeding sites very high in a marsh, or where excessive rainfalls lead to pooled water.

Note that higher tides and/or heavy rains often lead to widespread breeding. These events can result in a need to investigate nearly all breeding sites throughout particular environmental settings and lead to manpower stresses (which are usually addressed through authorized overtime, but may require additional staffing).

Salt marshes have specialized monitoring requirements. It is important to establish set monitoring points on a marsh for consistency's sake. These should be established in the high marsh, as the irregularly flooded portion of the marsh is the portion that breeds mosquitoes. In addition, it is very important, either through using multiple locations in each marsh, or through field crew observations, to record the extent of the flooding in the high marsh. This is because the size of the breed associated with a flood depends on the extent of the marsh that was inundated. The wetted eggs will concentrate in the retained pockets of water and develop into larvae. Therefore, it is also important to judge the stage of the larvae, and the speed with which the marsh is drying down. Surveillance for salt marsh mosquito larvae therefore requires determination of presence/absence of larvae in the marsh, the extent of the initiating tidal inundation of larvae are found, the dominant stage of the larvae, and the remaining water on the

marsh. The latter two parameters when combined with apparent development rates (which are temperature dependent) and evaporation forecasts (also largely temperature dependent), can result in a forecast of whether the brood will successfully hatch or not (without intervention).

Brackish and fresh tidal marshes also need to be sampled, as these are important habitats for other pestiferous mosquitoes in the County (such as *Aedes vexans*). Similar considerations hold for these environments.

In addition to the 15,000 catch basins monitored in 2005, two to three times that number (30,000 to 45,000) of catch basins should be monitored beginning in 2006. Additional basins will be selected based on a history of viral activity in the surrounding area. The age of the system, areas where maintenance may have been deferred and basins located at the terminal end of drainage systems or in low lying areas also are indicators that the basins may breed mosquitoes. Expanding the geographical extent of catch basin surveillance will allow the County to monitor breeding over a larger area, decreasing the potential of disease transmission. The catch basins will be sampled beginning in late May or early June for the presence of larvae. Basins will be revisited and re-sampled, as resources allow, preferentially during the middle (July) and end of the season (September), to monitor the development of any additional breeding activity and the efficacy of control efforts. Although some jurisdictions have quantified breeding in basins, presence/ absence of larvae is a more conservative indicator of the potential need for treatment.

It is recommended that SCVC increase the number of recharge basins that are sampled and visited in a manner similar to the one described above for catch basins.

The field crews will examine and determine the larval stages present in samples in the field. Training in identification allows for reliable staging of most larvae. This process is somewhat simplified by habitat specialization by many species, so that *Oc. sollicitans* is the dominant summer mosquito in salt marshes, and *Cx. pipiens* is the typical mosquito found in catch basins. Collected larvae will be stored in glass sample jars. The samples will then be transported to the laboratory for species identification by an entomologist.

### 3.3 Adult Mosquito Populations

Surveillance of adult mosquito populations is necessary for locating infestations that impact quality of life and/or public health, directing control efforts and evaluating the effectiveness of those efforts. Populations of adult mosquitoes are monitored using New Jersey light traps and CDC light traps. Population surveillance has some role in disease surveillance and disease risk management, but generally is considered to be a separate activity.

A New Jersey light trap consists of a light bulb placed above a metal cylinder with a fan fitted to the top of the cylinder. The fan draws mosquitoes that are attracted to the light into the cylinder, where they become trapped and die from dehydration. Traps operate continually, i.e., seven days per week, in an effort to sample all mosquito species that may be present in a given area. Dead specimens in the traps are collected three times a week.

New Jersey traps are set at fixed locations. They are used to directly measure the abundance of mosquitoes in an area. The data can be used to evaluate the effectiveness of the local larval control program. When a New Jersey trap is fortuitously placed, it can also be used to evaluate the effectiveness of an adulticide event. New Jersey light traps require power sources of 110 volts, which limits mobility. New Jersey traps are typically placed in a residential area with a history of mosquito problems to provide long term monitoring of the area. Because of their fixed locations, New Jersey traps are generally not optimally placed to monitor particular problem sites. They are usually considered to provide surveillance for a general area. This is reflected in their nomenclature, as they are generally named for surrounding hamlets (e.g., “the Oakdale New Jersey trap”). New Jersey traps are often maintained in the same location for years or even decades, providing valuable information on long term changes in mosquito populations.

The County currently has 27 New Jersey light traps at fixed locations throughout the County. The network is focused on the South Shore, and salt marsh mosquito problem areas. Traps are also set to monitor other coastal areas, and also to measure impacts from fresh water mosquitoes (see Figure 1). The County is proposing to augment this network with three additional trap locations on Fire Island, and potentially some others to measure ambient mosquito counts in areas with no control.

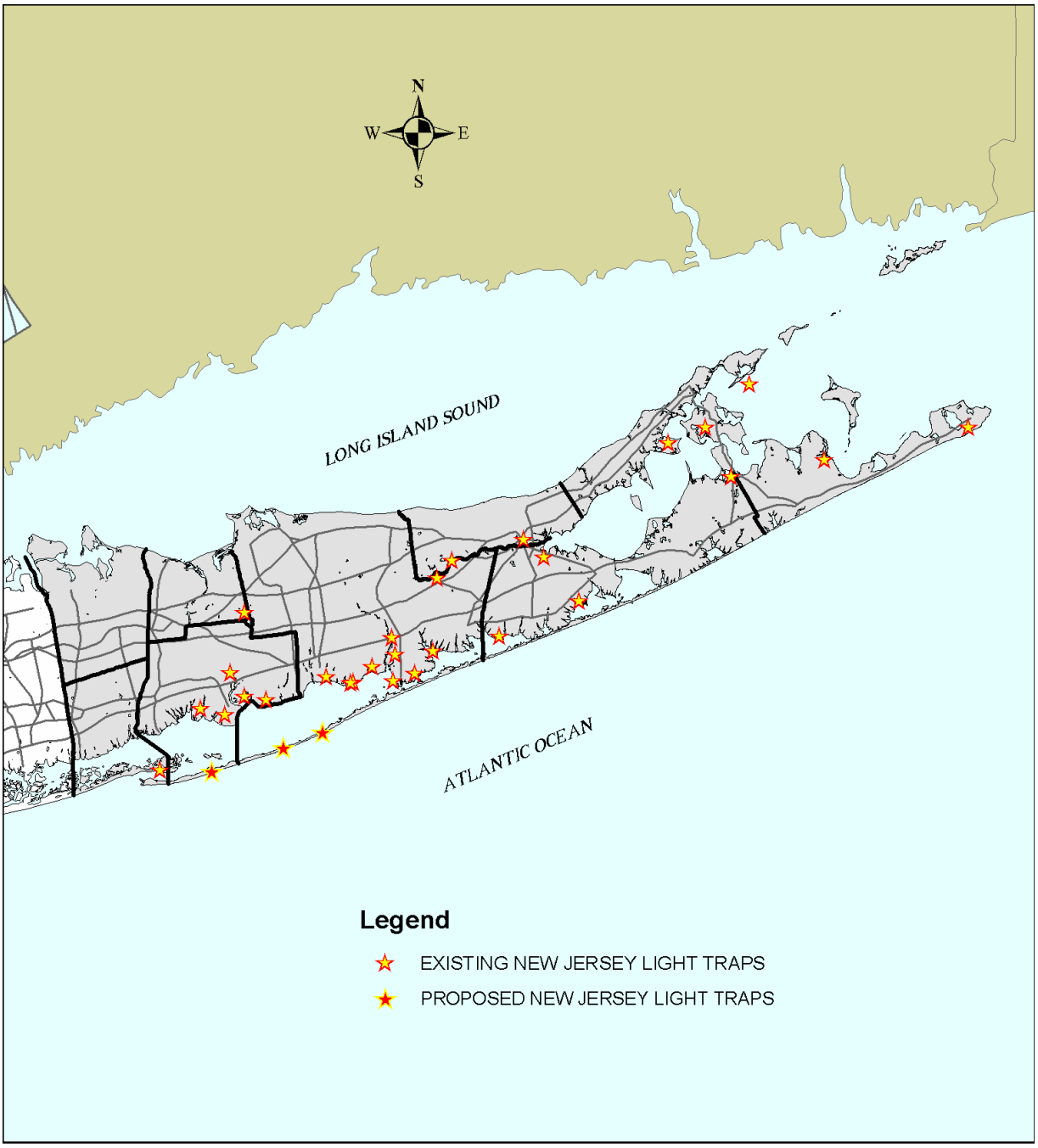


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FIGURE 1
-LONG TERM PLAN-
NEW JERSEY LIGHT TRAP
LOCATIONS

CDC light traps differ from New Jersey light traps in that they are baited with dry ice (frozen carbon dioxide [$CO_2$] or another $CO_2$ source. CDC light traps are more portable and are commonly used to collect human biting species and *Cs. melanura*. The dry ice placed in the trap releases $CO_2$ gas as it sublimates. This mimics the gas contained in the exhalations of active animals, thereby attracting mosquitoes, and increasing the catch compared to New Jersey traps. Mosquitoes are captured live. These traps are set in the evening and collected in the morning. CDC light trap samples analyzed for population purposes do not need to be preserved following collection (those for disease surveillance need to be cold preserved).

CDC light traps can be set at fixed locations. For example, Fire Island National Seashore (FINS) uses CDC traps for all of its population sampling. SCVC has tried to use New Jersey traps for routine population sampling because New Jersey traps do not require as much effort to set and monitor. SCVC has typically set CDC traps for population monitoring when special problems have been identified (and for disease monitoring purposes). CDC light traps can be set in areas where the volume of complaints increases, or where there are other indications that a mosquito biting problem will not be detected by the fixed New Jersey trap network.

The County currently focuses its population trapping efforts on areas with consistent mosquito problems. Due to resource limitations, several areas with a history of biting complaints are currently not monitored for the presence of mosquito larvae and lack traps to regularly monitor adult mosquito populations. Examples include areas along the north shore and Blue Point along the south shore, and some areas that are located some distance away from Yaphank, such as Shelter Island, Fishers Island, and Fire Island.

The County will acquire 12 new CDC light traps from the demonstration projects that have been conducted during the summer of 2005. The traps acquired from the summer demonstration projects will be allocated so as to address some of these problem areas. SCVC will determine if these traps will be adaptively placed or assigned to fixed locations. However, the logistics of sample retrieval from these areas would make regular monitoring a time consuming task.

A means of addressing the travel issue associated with sample retrieval is to establish identification stations. The stations would consist of a single room within an existing municipal building, located relatively close to the aforementioned areas, that is equipped with the ability to

allow field technicians to identify mosquitoes to the species level. This would eliminate the need for the technician to return the samples to the laboratory in Yaphank. Two potential sites for identification stations would be Fishers Island and Riverhead. The Riverhead location could service the East End light traps.

Fire Island represents a special case where travel and other factors affect surveillance. The need to use ferries to access Fire Island limits the County's flexibility in conducting surveillance. In addition, the limited ability to address mosquito problems due to FINS policies has made surveillance appear to not be as necessary for making treatment decisions as might be the case otherwise.

Several of the communities on Fire Island have established community mosquito control committees. These committees contact SCVC throughout the summer to discuss mosquito conditions and perceived treatment needs. Some committees monitor breeding areas and alert the County if larvae are seen, or a heavy rainstorm creates areas of standing water. Others report on biting mosquito densities. The County has found this information to be reliable and accurate.

FINS currently uses five CDC light traps (at William Floyd Estates West, Lighthouse Tract, Sailors Haven, Watch Hill West, and Smith Shores), and shares population information with SCVC. The Village of Saltaire currently operates a CDC light trap in Saltaire, primarily for disease surveillance reasons, because it has been a site of repeated viral detections in mosquito pools and dead birds. The Fire Island network will be expanded by SCVC adding New Jersey light traps in Saltaire, Davis Park and Fire Island Pines. Information generated from the SCVC trap network will be used, in conjunction with received FINS data, to determine the need to conduct regularly scheduled adulticide applications in the residential communities. Informal landing rate surveys will also be conducted prior to any adulticide application on Fire Island to confirm the presence of biting mosquitoes. Informal landing rate surveys differ from the formal landing rate surveys described below, in that they are not conducted over set courses of for precise times. Rather, the pesticide technician will observe if he or she is attacked by at least three mosquitoes while unprotected by DEET and while standing still, over an approximate 30 second time frame.

CDC light traps are also good tools for testing the efficacy of adulticide applications. They can be optimally set within a proposed treatment area, and, if the application was for disease control purposes, the post-application sample can also be tested to determine if viral activity was curtailed. SCVC proposes to use CDC traps to routinely test the efficacy of adulticide applications. A trap should be set out the night prior to the application. Trap contents will be analyzed during the morning hours of the scheduled application to determine if the conditions that suggested the need for adulticiding have been maintained. This surveillance may lead to reductions in the amount of pesticides used and result in a more focused use of resources. Traps should also be set post-application to determine the degree of population reduction caused by the treatment. Fluctuating weather conditions and other logistical considerations mean it will not always be possible to make a valid comparison with pre-application numbers. For this reason, control locations should be identified so as to provide means of appropriately interpreting the trap data.

Each year salt marshes in certain locations are plagued with mosquito infestations prompting many biting complaints from residents. Specific locations where these occur include:

- Bellport Village
- Brookhaven hamlet
- East Patchogue
- Mastic-Shirley
- Oak Beach
- Oakdale

Because these locations have historically resulted in repeated incidents of complaints regarding salt marsh mosquito broods, formal landing rate sites should be created in these areas. This type of surveillance is conducted by having personnel walk into and out of a grass field or marsh along the same path, wearing unprotected clothing on the lower half of the body (DEET may be worn on the upper part of the body). Depending on conditions, netting may or may not be worn

about the head. The number of mosquitoes that land on the unprotected clothing on the lower part of the body during a one-minute period is counted (mosquitoes do not bite through the clothing if appropriately thick pants are worn; because salt marsh mosquitoes that have disturbed from grass initially land low on the disturber, the DEET worn higher on the body does not appear to deter landing lower on the body). This method is targeted at *Oc. sollicitans*, which is so aggressive and opportunistic that it leaves daytime resting places when disturbed and seeks a meal from the disturbing mammal.

Table 4. Landing rate and bite count data collection protocol

| |
|---|
| Wear solid colored clothing |
| Have all counters wear the same color clothing |
| Use no perfumes |
| Wear DEET only on upper body |
| Take counts from a standing position |
| Disturb area vegetation before beginning the counts |
| Count only mosquitoes that land within view |
| If work is conducted after sunset, use a red filter on any light source |
| Use a standard form to record information |
| Use whole numbers, do not indicate a number |
| Collect mosquitoes for identification with an aspirator, if needed |
| Use consistent time periods (one minute is proposed) |

As part of the overall program for assessing adult mosquito populations, SCVC will seek to establish trap stations for background (ambient) levels of mosquitoes. These reference sites can help understand the natural fluctuations in trap catches that occur even in the absence of control, due to weather conditions and natural mortality. These traps should be set where it is as certain as is possible that treatment will not occur. Fire Island traps already being monitored may serve the requirement to collect salt marsh data. A trap in an upland portion of the William Floyd Estate might also be a good placement. However, such an array would have a large geographic bias towards the Brookhaven Town south shore (which, admittedly, is a locus of County mosquito problems). The other decision that needs to be made is whether to use CDC or New Jersey light traps. New Jersey light traps might fit the historical data base better, but the program is beginning to have a greater reliance on CDC light traps for management decisions.

## 3.4 Complaint Reporting and Hotline Response

Public complaints are a cornerstone of the County surveillance program (as is the case for most programs nationwide). SCVC responds to complaints regarding biting adult mosquitoes, larval breeding, clogged culverts, flooded marshes/swamps, and other sources of stagnant water. These complaints are received through the County's telephone complaint line. An inspector will visit the site within one to three days after receiving the complaint and submit a recommendation as to what action should be taken. Inspectors will provide information to homeowners, such as leaving door hangers listing information about the program and steps they can take on their own. As with other educational material, residents will be directed to the County's website for additional information. Inspectors will also determine the source of the problem. One outcome of the investigation may be to add the site to the mosquito breeding list.

Complaint calls are logged by type. This allows for maps to be prepared showing the timing and areas of complaints, both currently and historically. Complaints can be used to define the areas where mosquitoes are causing problems, as well as signaling areas that require further investigation and surveillance. Public reporting has proven to be an excellent monitoring tool and will continue to receive an expeditious response.

## 3.5 Disease Monitoring

*Mosquito Sampling*

Viral surveillance will continue to be conducted according to the latest CDC and NYSDOH guidelines and will likely continue to be primarily directed at EEE and WNV, with modifications to suit Suffolk County's unique environment. Suffolk County's ecological habitat diversity results in a large range of pests and vectors, requiring large amounts of traveling to implement surveillance and control measures. The large size of the County, coupled with resource limitations, has set some restrictions on where and how often traps can be placed or serviced. As an example, travel to the East End in summer is often impeded by resort traffic, meaning that efficiency is lost. Important in this regard is the current prohibition on taking County-owned vehicles home at night. If SCVC or ABDL personnel living on the East End could begin a day's work by collecting traps near home (and servicing them at night on the way home), instead of

driving to Yaphank to pick up a suitable vehicle and then returning east, more traps could be set and serviced.

A major means of monitoring for virus activity is through CDC traps. CDC light traps collect host-seeking mosquitoes, and keep them alive. The mosquitoes are then preserved using cold storage to ensure any viruses present can be detected using molecular biological techniques or culturing. Currently DNA analysis can identify WNV. Other viruses must be cultured and analyzed. Mosquitoes are identified and sorted by species in the laboratory. The groups of species ("pools") are then separated with the number of mosquitoes in each pool being noted. The ABDL has the technical means to test for WNV in mosquitoes at this time, but prefers to use state facilities for this purpose for worker safety reasons.

*Culex* mosquitoes that have had a blood meal and are seeking a location to oviposit are collected using CDC gravid traps. Gravid traps consist of a tub of stagnant, organic water with a collection net mounted over the tub. Gravid mosquitoes are attracted to the water and are drawn into the collection net by a fan. Gravid traps are adaptively placed in areas with a history of WNV viral activity or the sampled presence of viral indicators, such as viral positive birds. The trapped mosquitoes are collected, sorted, kept cool and tested as are samples from CDC light traps.

The fresh water wetlands that are currently monitored by the County due to a history of viral activity are listed in Table 5 and Table 6. These wetland areas are monitored using CDC light and CDC gravid traps in fixed locations. EEE is strongly associated with red maple and white cedar swamps that are the habitat of the key mosquito species in the biology of EEE, *Cs melanura.* WNV can be found in a wide variety of habitats. Intense WNV activity has been detected in several fresh water wetlands throughout Suffolk County. Andrew Spielman (Harvard School of Public Health) has postulated that the amount of EEE in fresh water wetlands increases as the wetlands undergo successional changes as part of the natural maturation process, resulting in an increase in the amount of available habitat, for *Cs. melanura*, which breeds in underground crypts formed among tree roots.

Table 5. Fresh water wetlands with a history of EEE.

| Wetland Location | Recent detections |
|---|---|
| Riverhead | 1990,1994,1996 |
| Robert Cushman County Park, Manorville | 1994,1996 |
| Bayview, Southhold | 1996 |
| Camp Hero State Park, Montauk | 1996, 2003 |
| Shelter Island | 1996 |
| South Haven County Park | 1996 |
| Connetquot State Park | 1997 |

Table 6. Fresh water wetlands with a history of WNV.

| Wetland Location | Year First Detected |
|---|---|
| Belmont State Park | 2000 |
| Blydenburgh County Park | 2000 |
| Saltaire (Fire Island) | 2000 |
| Heckscher Park | 2000 |
| Canaan Lake | 2000 |
| Nesconset | 2001 |
| Watch Hill, Fire Island | 2001 |
| Smith Shores, Fire Island | 2002 |
| Meeting House Creek, Aquebogue | 2002 |
| William Floyd Estate | 2003 |
| Area adjacent to the County Jail, Riverhead | 2004 |
| Headwaters of the Carmans River, Yaphank | 2004 |

With this in mind, SCDHS will revisit the County's fresh water wetlands that were last visited during an initial (1996) survey of potential EEE sites, as well as those that are not currently monitored, to determine if the ecology of these areas has matured sufficiently to support disease vectors by inventorying the types of vegetation present and looking for evidence of *Cs. melanura*. Examples of such areas are the major river corridors and the headwaters of the Peconic River. Sampling for *Cs. melanura* and other larvae should be performed and CDC light traps should be placed in the wetlands that have sufficiently matured to determine the population parameters of the mosquitoes currently inhabiting these areas. These areas should also be added to the list of fresh water wetlands that are currently monitored by the County on a regular basis. Extra field personnel and equipment, such as vehicles, would be necessary to sample these additional areas as well as more laboratory space for processing the samples generated as the result of increased surveillance.

Sampling frequency for these set locations is once a week, absent any indications of viral activity. If these are signs of local amplification, the frequency of sampling can be increased.

To augment virus activity surveillance, 44 CDC light traps and 44 gravid traps will be placed on a rotating basis at various locations throughout the County. These sites will be chosen based on history of viral activity or the presence of viral indicators, such as the finding of birds with WNV in the area. One field crew member for each of the nine townships (Babylon, East Hampton, Huntington, Islip, Riverhead, Shelter Island, Smithtown, Southampton and Southhold) and two field crew members for the Town of Brookhaven will each collect samples from eight traps per week. Expanding the trap network will provide the information necessary to assess the threat of potential disease transmission, including composition and abundance and seasonal and spatial distribution of mosquito vectors.

Fishers Island represents a particular issue for the County. There is no direct public transportation from Long Island to Fishers Island. Travel must pass through Connecticut. The County currently conducts no viral sampling on Fishers Island, although it has appropriate EEE habitat, and WNV habitat.

An identification station would not address the need for viral surveillance. The County could detail a technician whose major summer responsibility would be to collect samples from the traps on Fishers Island and return them to the ABDL each week. This person could utilize the ferry service that runs from Connecticut to Fishers Island, set a trap, stay overnight and return with the samples the following morning. A better alternative from the County's perspective would be to seek the services of a local pilot to fly from Fishers Island once per week return samples, from May to October. This is possible as several of the residents own and pilot airplanes, and have expressed interest in supporting mosquito control efforts.

FINS conducts its own viral surveillance. FINS has a network of CDC light and gravid traps (see Table 7). FINS is finding the effort required to monitor this network to be burdensome, and has indicated a willingness to transfer the responsibility to SCVC.

Table 7. Location and trap types used in mosquito surveillance at FINS

| Trap Type | Trap Location |
|---|---|
| CDC Gravid | William Floyd Estate East |
| | William Floyd Estate West |
| | William Floyd Estate Entrance |
| | Lighthouse |
| | Sunken Forest |
| | Watch Hill West |
| | Watch Hill |
| | Hospital Point |
| CDC Light | Lighthouse Tract |
| | William Floyd West |
| | Sailors Haven |
| | Watch Hill West |
| | Smith Shores |

Pools of mosquitoes are currently sent to NYSDOH for viral analysis. The County can send samples every day, but results are generally not available for at least five days, due to time requirements associated with weekends, mailing, sample preparation, a sample analysis, and data interpretation. Expansion of the ABDL to Biosafety Level-3 laboratory (BSL-3) (see below) would allow for local processing of mosquito samples, with overnight (or faster) results possible. This would increase the value of the information generated by the viral surveillance program immensely.

Arbovirus surveillance allows SCVC, in cooperation with SCDHS and NYSDOH, to gauge the potential for disease transmission and determine which control measure might be considered. SCDHS also remains in constant contact with NYSDOH to keep abreast of cases found elsewhere in the State as a gauge of possible threats faced here. SCDHS also maintains contacts with local veterinarians and stables for equine cases, and with hospitals for human cases of meningitis or encephalitis.

*Avian Sampling*

Through 2004, SCVC and SCDHS, in conjunction with NYSDOH and CDC, monitored for WNV using indicators such as unusual bird deaths or the number of dead birds, primarily corvids such as crows and blue jays, sighted in an area. Selections of dead birds were tested for actual

presence of the virus. The presence of WNV-positive birds is a strong indicator of virus activity in an area and correlates well nationally with other virus measures.

SCDHS estimated that approximately 44 percent of birds selected for testing were actually WNV-positive in 2003. The number of dead birds sited in an area did not provide information on the time or the place at which viral infection occurred, because of the mobility of crows. However, virus was frequently found in mosquito populations at locations where a bird died of WNV, since the bird was moribund it could infect the local mosquito population.

The ABDL has developed the capacity to conduct these tests locally. Local bird tests can be confirmed with NYSDOH, since the tests do not require use of all the birds. The confirmations have shown that local testing detects approximately 93 percent of infected birds, and there has only been one false positive.

Recent observations in New Jersey suggest dead corvids as a surveillance tool may become obsolete in providing an early warning of virus activity, since fewer corvids may succumb to WNV infection than in the past due to immunity and/or decreased bird populations. Therefore, the County needs to develop some other forms of surveillance to detect the virus, because, unlike EEE, it does not magnify in well-defined habitats. Other non-migratory bird species, such as house sparrows, may be useful as indicators of viral presence. Fledging sparrow deaths may serve as indicators of the presence of WNV in an area since they have been shown to be carriers of the virus. Unfortunately, as of yet, there has not been much research published on loss of young birds from the disease.

Viral activity in avian populations can also be monitored by:

- Netting
- Sentinel chicken flocks
- Obtaining blood samples from nestlings

*Netting Technique*

The capturing and handling of wild birds is controlled by federal law (Federal Migratory Treaty Act). Permits must be obtained from the USFWS and NYSDEC. Wild birds are often captured with a Japanese mist net. These fine black nylon nets are arranged in four shelves and come in various sizes. Small samples of blood sera (the fluid portion of the blood that contains antibodies) are removed from birds and the birds are banded before being released unharmed. Banding allows the agency to collect information on particular birds that can often be extremely useful for virus surveillance. For example, a bird sampled once and found to be negative, but recaptured and found to be positive, has obviously acquired the virus in the intervening time. Knowledge of the lifestyle of particular birds can mean that where the bird acquired the virus can be extrapolated, as well.

Site selection for net placement is based on the known or presumed presence of flyways. In Suffolk County, nets could be set up to cover the areas between CDC light and CDC gravid traps. The nets are set up before sunrise, and taken down by late morning. Nets are checked every 15 minutes or less, and collapsed if it rains as hypothermia would be a concern in birds captured in the rain. Captured birds are held in opaque cotton bags until processed. Blood is drawn from the jugular or wing vein. The following characteristics are recorded:

- Species
- Band number
- Age
- Sex
- Weight
- Body fat
- Molting pattern

In Harris County, Texas, seven of nine species caught in suburban areas, and testing positive for St. Louis encephalitis, are also found in Suffolk County. All seven (blue jay, Northern mockingbird, house sparrow, European starling, Northern cardinal, common grackle, mourning dove, and brown-headed cowbird) have been found to have positive antibodies for WNV, and so may be suitable for surveillance here. In Louisiana, testing found that the birds that had the highest percentage positive tests for WNV were the house sparrow and cardinal, and so their efforts focused on those species.

*Sentinel Chicken Technique*

Sentinel chicken serology is performed by placing chickens in an enclosed area for an extended period of time and testing their blood for the presence of antibodies to WNV and EEE. For example, the Los Angeles County West Vector Control District maintains and operates 15 flocks of chickens for this purpose that is strategically placed throughout its District. The chickens are bled once every two weeks from May through October. Only a very small amount of blood is required from each chicken every other week. ABDL staff similarly monitored sentinel chicken flocks in 2000. However, none of the chickens was ever found to be seropositive, although some of the flocks were located in areas where crows and mosquito pools were positive. The County has therefore abandoned this effort. This lack of success may be because of the mosquito species that are potentially transmitting the virus to the birds were not entering the cages or could not successfully feed on the chickens. New Jersey programs had similar experience with sentinel chickens. Sentinel chicken programs of California and Florida are monitoring mosquito species that readily feed on caged chickens such as *Culex tarsalis*. *Culex nigripalpus* is the dominant WNV vector in Florida. *Cx. pipiens*, is the northeastern WNV vector, and has difficulty feeding on birds that exhibit defensive behavior, as chickens are wont to do when faced with feeding mosquitoes.

*Blood Sampling*

Obtaining blood samples from nestlings is another way in which viral activity in avian populations might be monitored. This method is most useful when early in the season, as the birds are sessile, and there is no potential of being seropositive from earlier exposure, or exposure elsewhere. A positive result would indicate that virus is circulating in that immediate

area. However, nestlings often have left the nest just as WNV becomes of greatest concern (early August), which would mean changing surveillance tools at a key moment. In addition, permit issues make this kind of surveillance very difficult to administer.

Nonetheless, the County should seek to develop some new means of conducting sentinel surveillance for WNV. Whatever method is selected, testing of these samples could continue to occur in-house, with some samples sent to NYSDOH in Albany for confirmation and more general viral scans.

*Laboratory Testing*

In 2004, the ABDL acquired a machine known as the Rapid Analyte Measurement Platform (RAMP). This piece of equipment detects WNV infection in dead birds by analyzing the viral RNA antigens present in an oral sample obtained by swabbing the inside of a bird's mouth, and can provide results within 24 hours.

RAMP is not used by SCDHS for mosquito testing because the technique it employs is not as sensitive as the technique used by Taqman (another system used to test genetic material for virus). Thus, SCDHS would run the risk of failing to detect the presence of virus if it relied on RAMP to process mosquito samples. The ABDL has compared the accuracy of RAMP to that of the Taqman, by analyzing samples obtained from 122 birds, including 28 American crows (*Corvus brachyrhynchos*) and 63 blue jays (*Cyanocitta cristata*), and found the accuracy of RAMP to be greater than 93 percent. Thus, RAMP seems to be a reasonably reliable tool for use on birds in WNV surveillance. With the decline in the usefulness of dead birds, other uses should be considered for the RAMP system, such as supplemental testing of mosquitoes for rapid evaluation of the need for and effect of adulticide treatments.

Historically, SCDHS has had a no-cost service with the NYSDOH laboratory to process mosquitoes for viral testing. Under this service, a limited number of mosquito samples (45 per week) are batched and sent to Albany weekly, which yielded results in approximately 10 to 14 days. In order to decrease the time needed to obtain testing results, in 2005 the County contracted with the NYSDOH laboratory, and now has the ability to pay a nominal fee per sample ($25 per sample) but can send unlimited samples and unlimited shipments per week,

which provides far superior viral surveillance than under the no-cost service. This contract has increased the number of mosquito samples tested and reduced the turnaround time for testing results to approximately five to six days, which is extremely valuable for formulating and directing mosquito control strategies. With the proper laboratory facilities, the ABDL could employ the ABI 7900 HT (Taqman), which is a laser-coupled spectrophotometer, to perform a rapid version of the Polymerase Chain Reaction (PCR) test for viral testing. This machine uses the enzyme Taq polymerase (Taq is the moniker for the bacterium *Thermus aquacticus*) and a fluorescent dye to detect WNV in mosquitoes. When optimized, results would be available in approximately two days, which further reduces the time needed for obtaining testing results from NYSDOH. Thus, local testing of mosquitoes by the ABDL would greatly reduce this turnaround time, but the principle factors preventing local testing are lack of staffing and lack of a BSL-3 facility.

Taqman and RAMP are specialized for WNV testing, but the County has a need to test for EEE, since it has often been detected. Therefore, the County would like to conduct general viral surveillance to ensure that other arboviruses do not become established in the local mosquito population without detection. This requires the use of virus culturing and standard PCR. The laboratory has the capability to perform standard PCR, but culturing and processing viruses also requires that laboratory be equipped and certified at BSL-3, and meet certain Homeland Security requirements. The Long-Term Plan envisions, that as part of an already planned laboratory upgrade, that the ABDL will be improved and certified to BSL-3 standards. Until the laboratory has arboviral testing capabilities, the ABDL will attempt to improve the efficacy of sample processing and the speed with which results are obtained.

### 3.6 Mosquito Surveillance and Control Unit Upgrades

A unit within SCVC is the Mosquito Surveillance and Control Unit. This section should be asked to perform additional tasks under the Long-Term Plan. In addition to the unit in general having expanded, typical surveillance duties, a subunit should be formed that has special responsibilities. This work unit has been informally designated as the "QA/QC" team.

Major tasks for the QA/QC team would include:

- special surveillance responsibilities. The QA/QC team should be responsible for conducting early spring sampling for *Cs. melanura*, and seasonal sampling for *Cq. perturbans* and of tire stockpiles. These require special sampling techniques, which the team should master and employ.

- larvicide effectiveness measurements. This is described in detail in Section 6.

- adulticide need testing. On the night before non-Fire Island adulticide application for vector control purposes, CDC light traps should be set to ensure that a need for the treatment can be demonstrated. Need for control should be based on a trap count of approximately 100 human-biting mosquitoes, although this number is not intended to be a threshold, per se. Section 7 discusses treatment triggers in more detail.

- In association with adulticide need testing, treatment efficacy measures should be made for each non-Fire Island adulticide application (this is discussed in more detail in Section 7).

In addition, the QA/QC team could be assigned "research and demonstration" tasks, as needed, to test alternative technologies and methods that SCVC is considering adopting. An immediate use of this unit would be to develop an alternative bird sampling methodology, in conjunction with ABDL personnel, to keep WNV surveillance robust.

### 3.7 Data Management

*Surveillance*

Monitoring of larval mosquitoes is conducted on a weekly basis usually starting on Mondays from late-April through mid-September in approximately 2,000 identified natural breeding areas. Parameters, such as the weather and water condition, that are associated with each inspected larval breeding area, will be recorded on paper forms and directly entered into hand-held GPS units. The forms are returned to the office each day, and information from the hand-held units is downloaded into the Vector Control Management System (VCMS) software database.

VCMS is a program by Advanced Computer Resources Corporation that offers a database, Geographic Information System (GIS), and a mobile data collection system for vector control agencies. The software logs requests for service, breeding data, pesticide application data, regulatory requirements, trap data, weather data, and other information collected or used by vector control agencies. The software aids SCVC in evaluating treatment efficacy and determining where future surveillance efforts should be concentrated. It has been suggested that the County investigate replacing these useful devices and system because it is difficult to interface the VCMS information directly into a standard GIS system. The loss of specificity may result in some data entry and system inconvenience; and VCMS has provided good technical support that is unlikely to continue absent a vendor-sponsored system. However, the utility of direct entry of data into a GIS system should reap great rewards in data management, and eventual conversion of data into information useful for management decisions.

Computer terminals placed at individual stations throughout the laboratory will be used to enter data resulting from processing samples obtained from surveillance activities. The use of individual stations will streamline data entry by placing the terminal in the same area in which the sample is processed, preventing delays previously caused by sharing computers. These terminals will be linked to the County's GIS system in order to make the data accessible to all SCVC and SCDHS personnel as soon as possible.

*Complaint Reporting and Hotline Response*

All service request and response information will continue to be entered into hand-held GPS units in the field for download into the main system at a later time. This shall provide SCVC leadership with an accurate picture of current field conditions and activities, while eliminating the need for data entry back at the office and reducing the need for temporary staffing. The database will allow the County to monitor recurrences in the same area(s) weekly, monthly and yearly and determine the efficacy of any action(s) taken. Use of this database will enable the SCVC to rapidly identify and target problem areas, allowing resources to be more efficiently applied. In addition, the completeness of pesticide reports can be continually checked in this system, ensuring compliance with State reporting laws.

*Data Analysis and Reporting*

The Superintendent and the Director of the ABDL currently analyze collected data, with assistance from an entomologist, a GIS specialist, and ABDL staff. The type of data collected and resource allocation limit the scope of statistical analysis currently performed on collected data.

At this time, the ABDL Director produces a summary of the season's findings and annual work plans summarize operations from the previous year. However, a comprehensive annual report, including the season's results for all program areas, is not produced due to resource allocation limitations. This should change. It is clear that vector control programs need to justify their activities by collecting appropriate information and then making the information available to the public. A more in depth statistical analysis of laboratory and field data should be performed and an annual report should be produced detailing these results. This report could be posted on the County's website.

# 4. Source Reduction

## 4.1 Background

Source reduction is also known as physical or permanent control. It consists of the elimination of larval habitats or the rendering of such habitats unsuitable for larval development. This can be accomplished by properly discarding old containers that hold water, or by more complex measures such as implementing progressive water management techniques, such as those known as Open Marsh Water Management (OMWM), which control salt marsh mosquitoes and restore degraded habitat as an added benefit. The Marsh Management Plan has been developed separately, and is included as Appendix 1.

Mosquitoes require stagnant water to breed. Stagnant water is not necessarily "polluted," which is a term used by mosquito control professionals when describing water that has high organic matter content. In Suffolk County, most of the mosquito species that bite humans actually need water that is clear to relatively clear. Others, however, prefer or even need to breed in water that has a heavy organic burden.

The scope of mosquito breeding in Suffolk County includes at least 2,000 natural breeding areas and 100,000 artificial sites such as roadside catch basins, recharge basins, etc. Not included in this number are the innumerable domestic breeding sites that are created by property owners or their tenants.

The female adult mosquito will lay her eggs in practically any wet location. Breeding sites are often classified as permanent, transient, and containers. Some specific locations used by mosquitoes include:

- Ponds
- Puddles
- Tire Ruts
- Swamps

- Marshes
- Tree stumps
- Abandoned swimming pools
- Buckets
- Cans
- Bird baths
- Dirty gutters
- Stored tires

This list emphasizes locations over which people can take responsibility, although any place where water collects, even temporarily, is capable of supporting mosquito breeding. The IPM approach to mosquito control concentrates on eliminating mosquitoes before they become adults. This is because larval mosquito breeding sites can be readily identified and, generally, are relatively small in area. Once identified, most of these listed sites can be addressed to stop or minimize breeding. By contrast, the adult mosquito can fly many miles and cause problems over a much wider area. Thus, larvae are condensed within delineated habitats, but adults disperse widely following emergence.

The by-products of the activities of man have been a major contributor to the creation of mosquito breeding habitats. An item as small as a bottle cap or as large as the foundation of a demolished building can serve as a mosquito breeding area. Sanitation is a major part of all IPM programs, exemplified by tire removal, clearing waterways, catch basin cleaning, and container removal.

Public education is an important component of source control. Many agencies, including SCDHS, have public school education programs that teach children what they and their families can do to prevent mosquito proliferation. Suffolk County does more, including website maintenance, distribution of pamphlets, telephone hotlines, site visits, media relations and press

releases, and presentations to citizens' groups and associations. Even minor housekeeping improvements can have significant disease risk reductions, because WNV vectors such as *Cx. pipiens* and *Oc. japonicus* often breed in artificial containers that hold water in and around the home. In fact, educating the public to eliminate or empty these is the only practical way to reduce these mosquito sources.

Source reduction can be the most effective and economical method of providing long-term mosquito control. It can help to reduce the need for pesticide use in and adjacent to the affected habitat. For example, the removal of discarded tires from the environment, whether they be individually littered items or tires that have been collected into a large stockpile, is widely noted as a basic step in reducing human health risks. This is because many encephalitis-bearing mosquitoes will use the temporary breeding habitats that invariably occur in tires. Tire removal from isolated dumpsites is also credited with aesthetic improvements, and tire removal reduces fire threats when the larger stockpiles are eliminated.

This portion of the plan will focus on household and institutional means of conducting source control. Water management will be addressed briefly because of the extensive discussion contained in the attached Wetlands Management Plan.

### 4.2 Household and Institutional Source Controls

Public education is the first step in realizing household source control. SCDHS has greatly expanded its role in educating the public about the public health importance of mosquito controls, and its educational outreach has been discussed above in Section 2. It is important to realize that many simple, common-sense steps such as maintaining items such as bird baths, or emptying containers in the yard, can have substantial impacts on risks associated with disease transmission. SCDHS will address these issues through presentations to groups and schools, its "Fight the Bite" and "Dump the Water" programs, and using the Citizens Advisory Committee pamphlet, "Mosquito Control and Prevention at Home."

Tire disposal needs to be addressed. One way is by expanding the education program, as discussed in Section 2. It is important that other departments in County government (such as Parks and Public Works) understand the public health importance of removing littered tires when

encountered. Similarly, since the towns are the level of government responsible for zoning and waste management in the County, they must understand the potential impact to public health when tires are not promptly removed from improper disposal sites. It may be that the County can provide useful resources to allow towns to address tire stockpile issues because of the public health.

Similarly, farmers, farm educators and advocates, and others involved in agricultural water use issues need to understand that the over-irrigation of fields can not only waste water, but generate mosquito breeding problems. This tends to be a greater problem in drier areas, and areas where soils are not as porous as they tend to be here. Thus, California is a leader in this source reduction field. Nonetheless, it may be that this may have greater resonance on the East End where water quantity and problem mosquito populations may become more pressing issues with greater population densities. SCVC already maintains certain water management structures in agricultural areas to drain standing water, and should expand its outreach efforts, perhaps through Cornell Cooperative Extension, to reach farmers on this issue, again, as discussed in Section 2.

Another addition to the program, discussed in Section 2, is storm water management structure maintenance. Not only should municipal (including County and State) departments be targeted, but those responsible for commercial properties and private homeowner associations should be engaged. Benefits associated with decreased flooding are most probably well-understood, but public health improvements are possible.

A survey of catch basins conducted as part of the development of the Management Plan found that older systems tend to support more breeding than do newer systems. Since the technologies employed have not changed, the implication is that a lack of maintenance has impaired the functioning of these systems. This not only reduces compliance with USEPA Phase II regulations, but threatens public health. As mentioned above in Section 2, these underground facilities are prime *Cx. pipiens* habitat, potentially the major vector for WNV. Eliminating habitat for this mosquito species has immediate implications for the risks faced by people in the immediate vicinity of the water management structures receiving the maintenance.

The initiation of action by SCVC in household situations is often a complaint phone call. SCVC receives on the order of 3,000 phone calls for service per year. These are logged into the SCVC computer system, assigned to an inspection team on the basis of the geographical location of the complaint. Each complaint that is received is responded to within one to three days.

The initial response is to go to the complainant's house. State law allows SCVC wide latitude with regard to investigating and reacting to mosquito problems, so even if the complainant is not home some investigation will be undertaken.

CDC notes that sanitation is "a major part of all integrated vector management programs." Problems of neglect, oversight, or lack of information on the part of property owners are the types of problems most often faced by agency inspectors, nationwide. This is also true in Suffolk County.

In all cases, an immediate assessment of the problem is made: are mosquitoes present, and, if so, what species are involved, and what is the source of the problem. The primary investigative tool is larval dipping in potential source area water. Samples of larvae are returned to the laboratory for complete evaluation of the problem; however, field crews are trained in larval identification, as well. The larval stages and, very often, species involved can be determined in the field. This can allow for accurate and effective choices should larviciding be determined to be the appropriate course of action. The follow-up laboratory identifications ensures that novel or unusual species are identified and noted, and as QA/QC for the field identifications.

Most often, the source of the problem is immediately obvious: a breeding habitat, such as an abandoned or poorly maintained swimming pool, a recharge basin that retains water, or other sources of permanent water. Permanent water mosquitoes often breed continuously, so that the water represents a constant source of new adults. Removing the water will break the breeding cycle, so that the numbers of adults will decline with the inevitable mortality of the adult mosquitoes. Therefore, draining the water source is the best solution for a local household mosquito problem.

Sometimes that is not possible, as when the source of water is as large as a swimming pool or relatively unmanageable as a recharge basin. Ecologically isolated, artificial bodies of water

such recharge basins can be treated by stocking *Gambusia* (mosquito fish). If the water quality is marginally acceptable, these fish will consume larvae even when there is a great deal of vegetative cover. SCDHS, through the ABDL, purchases these fish from commercial suppliers. This decision should be carefully considered, however. These fish are not native to Suffolk County, and therefore are a potential invasive species should they escape the basin. Secondly, the basin must retain sufficient water of high enough quality through the season for the *Gambusia* to survive. Third, if there are no native fish in the recharge basin, and it supports water seasonally, it may be functioning ecologically as a vernal pool, and serving as a home to a host of aquatic breeding insects and animals, especially amphibians, that are likely to be vulnerable to fish predation. For this reason, *Gambusia* has lost much of the luster that it once had for County source reduction purposes. Instead, the County should consider using species that are already found in County fresh waters for these purposes. One species that is especially promising is the fathead minnow (*Pimephales promelas*). Although this fish does not have the reputation for larval consumption that earned *Gambusia* its common name, it can and does predate on mosquito larvae. It is a very hardy fresh water fish, prefers slow-moving or still waters as habitat, tolerates high temperatures, high nutrient content water, relatively low dissolved oxygen conditions, and can live under a range of pH levels. Although not native to Long Island, it is established in all waterways throughout the County, apparently with little to no ecological impact. It is not as readily available from commercial fish hatcheries as *Gambusia* is, but New Jersey has raised them in hatcheries (so it is possible to stock).

Still, due to potential impacts to areas where fish may not be found (or are not common), it is best if fish only be stocked in basins where they have been stocked before, and only after reconnaissance that shows there is no hydraulic exit from the basin (such as an overflow outlet) that could result in a release to ponds that may serve as fish-free environments. Potential new sites need to be carefully assessed in terms of the three major risk factors discussed immediately above. The introduction of any predator, although especially those that are non-native predators (such as tadpole shrimp or copepods), can have great, unintentional environmental impacts, and should only be undertaken at new sites if a careful impact assessment has been made.

Another attractive solution to mosquito breeding when recharge basins are slow to drain is to contact the basin owner and arrange for maintenance of the basin. Typically, this involves

scraping and removing low permeability material that has settled from the retained storm water, and created a more impermeable bottom than the basin was designed to have. Suffolk County basins typically are constructed deep enough not only to hold expected storm water volumes, but to access high permeability sands if they are not immediately available. The ecology of the basin needs to be assessed prior to undertaking this step, however (if flooding is not an immediate, overriding concern). Recharge basins that retain water can be important water courses, especially on Long Island where high soil permeability means that surface water is not plentiful in many areas. Those that permanently hold water can support a coastal plain pond type of ecology, fostering a great diversity of plants and animals due to fluctuating water levels. Recharge basins that only intermittently hold water may serve as vernal pools, and be key habitat for biota such as amphibians that need the isolation from many predators that impermanent water bodies provide.

This assumes that the basin is not an anoxic, eutrophied, contaminated pool of water that is not utilized by much other than breeding by *Cx. pipiens*. Many of these poorly draining basins do not provide the necessary water storage and recharge functions they were designed for, as well, and so maintenance would be required even absent a mosquito problem.

A stop-gap measure for such systems, until maintenance can be arranged for, would be to apply larvicides to control breeding. Timed release formulations of larvicides such as *Bacillus thuringenesis var israelensis* (Bti), *Bacillus sphaericus* (Bs), or methoprene can be in order. Methoprene time release formulations should not exceed 45 to 60 days, as the longer formulations run the risk of developing resistance. Larvicides can be applied in other kinds of enclosed water bodies, such as the ecologically-sound basins discussed above, as the research and risk assessment has generally found little to no evidence of ecological injury from these biorational compounds. The discussion of larvicide use will be more complete, below.

For purely artificial, non-ecological systems such as an abandoned cistern or swimming pool, larvicide applications are an effective means of breaking the breeding cycle. Where more complex, natural systems seem to be the source of the homeowner complaint, such as a fresh or salt water wetland, then more sophisticated intervention is required.

Once an inspection team has investigated a site, it will discuss its findings and actions with the homeowner, with the intention of teaching the homeowner, should the cause of the problem be self-inflicted, or the neighbor (or municipality or agency), should the source be nearby and identifiable. Pre-printed check-off cards are used when the involved landowners are not at home. These cards invite follow-up phone calls to explain the findings and actions taken, and to try to ensure that the problem does not reoccur through homeowner education.

Rarely, and only with extensive, although potentially time-compressed investigation, would adulticiding be considered in response to homeowner complaints. A nexus of complaints can be an important surveillance tool. For example, some mosquitoes, such as the tree-hole (and tire) mosquito *Oc. japonicus*, can be difficult to capture in the most common surveillance traps. Complaints spurring observations of these mosquitoes can result in determinations that control of the adults is not necessary.

Although the Long-Term Plan intends to increase the long-term, set surveillance network, not all salt marsh areas in the County will be adequately covered by the New Jersey or CDC light traps. It is possible that a brood will be generated in one or more marshes, and cause a localized, but intense problem that may require adult control, without causing any increases in surveillance counts. For areas such as Fire Island, where geographic conditions make regular surveillance difficult, resident complaints serve as a valuable means of determining when more precise surveillance needs to be initiated. Adulticiding threshold and conditions are discussed in much more detail below; it needs to be understood that several complaint calls to the SCVC hotline are **not** the necessary and sufficient conditions to initiate an adulticide application in a neighborhood.

Each year during the off-season, prior to the development of the coming year's brochure, field personnel from SCVC should interact with the health educators from SCDHS. This will allow transfer of information from the field to the educators regarding the kinds of persistent problems that are not being reduced through current education programs. In addition, field crews will be made aware of the current focus and ranges of materials used by the educators, which should enhance the field crews' education efforts, as well.

## 4.3 Water Management

The Wetlands Management Plan, together with its its associated Appendix, the Best Management Practices manual, has been appended in its entirety to the Long-Term Plan (see Appendix 1). The following, largely excerpted from the Executive Summary of the Wetlands Management Plan, summarizes this most important element of the Wetlands Management Plan.

*Overview*

Over a 12 year period, Suffolk County plans to address the vector control and ancillary wetland management needs for all 17,000 acres of tidal wetlands in Suffolk County. The approach of major marsh restoration, natural reversion, and other best management practices will be a radical departure from the current program of maintenance of the legacy grid ditch water management system.

Progressive water management will be implemented in over 4,000 acres of tidal wetlands that have been identified as mosquito breeding problem areas. The goals of this initiative are pesticide reduction and habitat enhancement, including maintaining or increasing biodiversity and *Phragmites* control. It is estimated that approximately 4,000 acres of tidal wetlands will undergo reversion, because of low mosquito breeding potential and/or distance from points of dense populations of people. In those areas, natural processes will gradually undo the construction of ditches across the marshes. In the long run, reversion is not necessarily ecologically optimal; other restoration options may need to be considered for purposes other than vector control.

The remaining 9,000 acres will be assessed over the coming decade, with some being actively restored, and others subjected to reversion processes. The policy in these areas will be one of presumptive interim reversion (i.e., no ditch maintenance unless deemed necessary for ecological or mosquito control purposes). It is expected that less than four percent of the County's tidal wetlands (less than 600 acres) will be subject to ditch maintenance over the next decade.

*Ditch Maintenance Policy*

Suffolk County has inherited a legacy of approximately 17,000 acres of tidal wetlands which have been fundamentally altered. In the 1920s and 1930s, these tidal wetlands were substantially grid-ditched, in an effort to remove stagnant water and mosquito-breeding habitat. Natural features, such as ponds and pannes, were affected in many settings, and biological communities in the wetlands were altered.

The Wetlands Management Plan represents a significant departure from seven decades of grid-ditch maintenance policy. Instead of committing to maintain the grid ditch network as a means of controlling mosquitoes, Suffolk County will instead apply more nuanced criteria to determine the best means of managing its salt marsh resources. For now, plans include a presumptive policy of reversion, where wetlands that pose no mosquito problems will remain untouched while long-term plans for restoration are developed and implemented. Existing water management systems (ditches, culverts, and other structures) will normally be either left alone, if not needed for mosquito control, or upgraded to BMPs as outlined in the Plan. In some cases, implementation of BMPs is not immediately feasible due to lack of pre-project information or institutional factors such as landowner policies. Implementation of BMPs may also not be immediately feasible due to lack of resources. For instance, if major tidal flow restoration is desirable but is currently too expensive because it involves major road work, interim measures should be taken while these resources are sought if the alternative is a loss of habitat and/or an increased reliance on pesticides.

Assuming Long-Term Plan water management policies are implemented (especially open marsh water management), the general presumption will be against maintenance of ditch systems. However, in limited circumstances, existing structures may be maintained on an interim basis, when the following conditions are met:

- Deterioration of or damage to structures is resulting in a significant mosquito problem, as evidenced by larval and/or adult surveillance, serious enough to require control. An example would be a collapsed pipe that restricts tidal flow and results in a need to larvicide an area. Or:

- Failure to maintain the structures would result in the loss of resource values, such as fish passage or tidal flow, or loss of vegetation due to freshwater impoundment. Or:

- Failure to maintain the structures would result in a hazard or loss of property as a result of flooding.

Benefits to be expected from the work include:

- Maintaining or reconstructing the existing structures will improve water circulation or provide fish habitat sufficient to reduce the need for pesticide application.

- Maintaining the structures is compatible with habitat values that existed prior to the failure or deterioration of the structures.

- Maintaining the structure will prevent flooding or other hazards.

Constraints on any maintenance of a pre-existing ditch system include:

- The structures will be maintained essentially in-place and in-kind.

- Disruption of wildlife habitat due to construction will be minimized by limiting work areas and/or by using seasonal constraints.

- Listed species will not be adversely impacted.

- Interim maintenance will not lead to excessive drainage that would result in a loss of wetlands values.

- The action will not lead to increased or more direct conveyance of inputs from storm drains or other structures.

- The action will not preclude the implementation of BMPs when resources and/or institutional considerations allow.

Given the above, it is expected that less than 50 acres per year will be subject to ditch network maintenance. All maintenance will be summarized in the annual water management reports, and will be conducted in accordance with a MOU with the SCDHS Office of Ecology.

*Progressive Water Management (OMWM)*

The proposed policy change is predicated on the ability to conduct a broad variety of best management practices and, specifically, to implement the kinds of progressive water management that are often labeled as OMWM. All mosquitoes spend larval stages as aquatic organisms, and source reduction is an essential component of mosquito control as practiced through IPM. Source reduction through OMWM leads to impressive reductions in successful mosquito breeding, and so leads to major reductions in the number of applications and overall usage of pesticides. In addition, this kind of water management also increases overall marsh habitat diversity and wildlife values.

This holistic approach has successfully been demonstrated for the first time on Long Island, as part of this Wetlands Management Plan, at the Wertheim National Wildlife Refuge. Permitting of this project was a major accomplishment, in that it overcame concerns raised by State regulators regarding potential impacts to existing important natural resource attributes of ditched marshes, and marsh loss in tidal settings, together with a lack of monitoring and documentation for past OMWM demonstration projects. The degree to which project plans addressed these concerns coupled with the first blush of success at the site in controlling mosquito breeding and enhancing natural resource values may allow NYSDEC to consider these options that might not have passed regulatory muster a short while ago. Continued cooperation between federal and state agencies will be critical to ensure that projects similar to Wertheim will be implemented throughout Suffolk County.

*Wetlands Management Plan Approach*

The Wetlands Management Plan consists of seven sections, the first of which addresses goals and numerous objectives. In the second section, a framework for managing larger, more ambitious projects is discussed. A key feature is the creation a Screening Committee to review and approve the major projects (see Figure 2).

In section three, the 15 Best Management Practices and four Interim Management Actions are discussed (Tables 8-11). The actions are aimed at reducing mosquito populations utilizing methods that either minimizes potential environmental change, or maximizes the enhancement of particular natural resource values.

Section 4 and Section 5 of the Wetlands Management Plan address plan implementation and resource needs of SCVC to undertake this Wetlands Management Plan, respectively. The need for streamlined and dedicated State processes is highlighted. Vector control program needs may be eligible for restoration grant opportunities, as well as the Suffolk County Water Quality Protection and Restoration Program (the Quarter Percent Sales Tax). Section 6 establishes a Timeline for reaching Wetlands Management Plan goals, and in Section 7 the County's salt marshes are prioritized in terms of those requiring restoration to address mosquito management needs, sites that appear to be best suited for reversion, and those areas requiring closer study before determining overall management needs.

*Freshwater Wetlands*

In New York State, fresh water regulations do not allow for much manipulation of the existing hydrology of the marshes. This means that there are very few options in terms of mosquito-related water management and restoration. Source reduction and larviciding are the main means of addressing mosquito problems associated with freshwater wetlands (see above and below).

*Underlying Data and Interagency Approach*

This plan is based on tremendous amount of collaboration among agencies within the Wetlands Subcommittee. It is also the result of an exhaustive literature review and comprehensive field work, which is reflected in Task 3 (Literature Review) and Task 7 (21 representative wetland areas, totaling over 2,000 acres, have been evaluated in detail). The first digital tidal wetlands map, for all County wetlands, has been produced, and the Remote Sensing project is expected to provide a continuing and cost-effective means to implement the long-term program.

Table 8. Management Activities for Minimal or No Action

| BMP | Action | Factors to Consider | Benefits | Impacts | Equipment to be used | General Compatibility With Tidal Wetlands 6 NYCRR Part 661 |
|---|---|---|---|---|---|---|
| BMP 1. | Natural processes (reversion/no action) | - Default option<br>- Land owner prefers natural processes to proceed unimpeded<br>- Natural reversion is actively infilling ditches<br>- No existing mosquito problem | - Return to pre-ditch hydrology<br>- More natural appearance/processes<br>- Requires no physical alterations | - Possible increase in mosquito breeding habitat, creation of problem<br>- Loss of ditch natural resource values<br>- Loss of tidal circulation<br>- Phragmites invasion if fresh water is retained on marsh<br>- Drowning of vegetation if excess water is held on marsh | Not applicable | NPN |
| BMP 2. | Maintain/repair existing culverts | - Flooding issues<br>- Are existing culverts adequate for purpose?<br>- Are existing culverts functioning properly? | - Maintain existing fish and wildlife habitats<br>- Maintain tidal flow and/or prevent flooding | - Continue runoff conveyance into water bodies<br>- Roads & other associated structures | - Hand tools (minor maintenance)<br>- Heavy equipment for repair | GCp |
| BMP 3. | Maintain/ reconstruct existing upland/ fresh water* ditches | - Flooding issues<br>- Are existing ditches supporting flood control?<br>- Are existing ditches needed for agricultural uses? | - Maintain existing fish and wildlife habitats and hydrology<br>- Prevent or relieve flooding<br>- Support turtle habitat<br>- Provide fish habitat | - Continue runoff conveyance into water bodies<br>- Perpetuate existing degraded conditions<br>- Excess drainage | - Hand tools (minor maintenance)<br>- Heavy equipment for reconstruction (rare) | NPN (6 NYCRR Part 663) |

Please note that other jurisdictions besides NYSDEC may also regulate activities in wetlands.

Table 9. Management Activities for Minor Impacts

| BMP | Action | Factors to Consider | Benefits | Impacts | Equipment to be used | General Compatibility With Tidal Wetlands 6 NYCRR Part 661 |
|---|---|---|---|---|---|---|
| BMP 4. | Selective Maintenance/ Reconstruction of Existing Salt Marsh Ditches | - Local government issues and concerns resolution<br>- SCDHS Office of Ecology review<br>- Mosquito breeding activity<br>- Land owners long-term expectations<br>- Overall marsh functionality<br>- Ditch maintenance is to be selective and minimized | - Enhance fish habitat<br>- Maintain existing vegetation patterns<br>- Maintain existing natural resource values<br>- Allow salt water access to prevent/control Phragmites<br>- Reuse pesticide usage | - Perpetuate ongoing impacts from ditching | - Hand tools (minor maintenance)<br>- Heavy equipment for reconstruction | NPN |
| BMP 5. | Upgrade or install culverts, weirs, bridges | - Flooding<br>- Flow restrictions<br>- Associated marsh impacts<br>- Cooperation from other involved departments | - Improve tidal exchange and inundation<br>- Improve access by marine species<br>- Increase salinity to favor native vegetation<br>- Improve fish habitat & access | - Negative hydrological impacts<br>- Changes in vegetation regime | - Heavy equipment required | GCp |
| BMP 6. | Naturalize existing ditches | - Grid ditches<br>- Mosquito breeding activity<br>- Landowner needs<br>- In conjunction with other activities | - Increase habitat diversity<br>- Increase biofiltration<br>- Improve fish habitat and access by breaching berms | - Hydrology modification<br>- Minor loss of vegetation<br>- Possible excess drainage | - Hand tools (minor naturalization)<br>- Heavy equipment for major | NPN/GCp |
| BMP 7. | Install shallow spur ditches | - Mosquito breeding activities<br>- Standard water management not successful (continued larviciding) | - Increase habitat diversity<br>- Allow higher fish populations<br>- Improve fish access to breeding sites | - Drainage of ponds and pannes<br>- Hydraulic modification<br>- Structure not stable | - Preferably hand tools | NPN/GCp |
| BMP 8. | Back-blading and/or sidecasting material into depressions | - Mosquito breeding activities<br>- Standard water management not successful (continued larviciding) | - Improve substrate for high marsh vegetation<br>- Compensate for sea level rise or loss of sediment input<br>- Eliminate mosquito breeding sites | - Excessive material could encourage Phragmites or shrubby vegetation<br>- Materials eroded so that application was futile | - Heavy equipment required | NPN or GCp |
| BMP 9. | Create small (500-1000sq. ft) fish reservoirs in mosquito breeding areas | - Mosquito breeding activities<br>- In conjunction with other water management<br>- Natural resource issues | - Increase wildlife habitat diversity/natural resource values<br>- Improve fish habitat<br>- Eliminate mosquito breeding sites<br>- Generate material for back-blading | - Convert vegetated area to open water with different or lower values | -Heavy equipment required | Status Undetermined |

Please note that other jurisdictions besides NYSDEC may also regulate activities in wetlands.

Table 10. Management Activities for Major Impacts

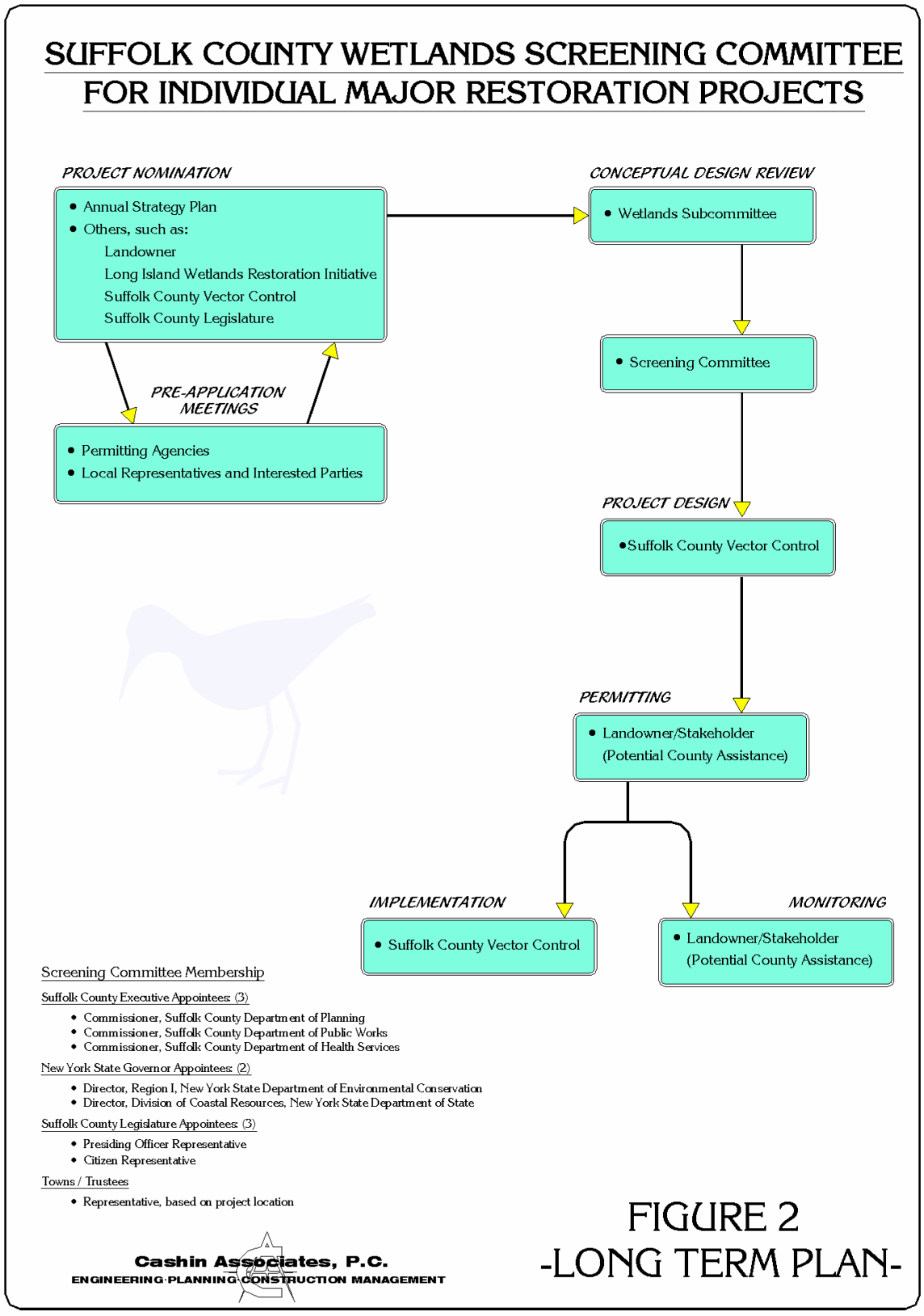
| BMP | Action | Factors to Consider | Benefits | Impacts | Equipment to be used | General Compatibility With Tidal Wetlands 6 NYCRR Part 661 |
|---|---|---|---|---|---|---|
| BMP 10. | Break internal berms | - Water quality (poor)<br>- Standing water (mosquito breeding)<br>- Impacts on structural functions | - Allow access by marine species<br>- Prevent waterlogging of soil and loss of high marsh vegetation<br>- Improve fish access to mosquito breeding sites<br>- Prevent stagnant water | - Changes in system hydrology<br>- Excessive drainage of existing water bodies<br>- Introduction of tidal water into areas not desired | - Hand tools (minor)<br>- Heavy equipment (major) | Pip |
| BMP 11. | Install tidal channels | - Improve water quality<br>- Tidal ranges and circulation<br>- Increase salinity (invasive vegetation)<br>- Natural resources enhancement | - Improve tidal exchange<br>- Improve access by marine species<br>- Increase salinity to favor native vegetation<br>- Improve tidal inundation<br>- Improve fish habitat | - Changes in system hydrology<br>- Excessive drainage or flooding of uplands<br>- Increase inputs from uplands into water body | - Heavy equipment | P |
| BMP 12. | Plug existing ditches | - Improve fish habitat<br>- Tidal ranges and circulation<br>- Prevent upland inputs<br>- Natural resources enhancement | - Return to pre-ditch hydrology & vegetation<br>- Reduce pollutant conveyance through marsh<br>- Provide habitat for fish & wildlife using ditches<br>- Retain water in ditch for fish habitat<br>- Deny ovipositioning sites | - Changes in system hydrology<br>- Reduce tidal exchange<br>- Reduce fish diversity in ditches due to lack of access<br>- Impoundment of freshwater could lead to freshening & Phragmites invasion<br>- Possible drowning of marsh vegetation | - Heavy equipment | P |
| BMP 13. | Construct ponds greater than 1000 sq.ft. | - Landowner's needs<br>- Water fowl habitat<br>- Natural resources enhancement<br>- Aesthetic improvements | - Increase habitat values for targeted species and associated wildlife<br>- Improve habitat for fish<br>- Eliminate mosquito breeding sites | - Changes in system hydrology<br>- Convert vegetated areas to open water with different and possibly lower values | - Heavy equipment | P |
| BMP 14. | Fill existing ditches | - Landowner's needs<br>- Aesthetic improvements<br>- To restore pre-ditch hydrology<br>- Vegetated areas | - Return to pre-ditch hydrology and vegetation<br>- Reduced likelihood of pollutant conveyance through marsh<br>- Create vegetated habitat to replace that lost by ditches or by other alterations<br>- Deny mosquito breeding habitat by eliminating stagnant ditches | - Potential to create new breeding habitats if ditches are not properly filled or by making the marsh wetter<br>- Loss of ditch habitat for fish, other marine species & wildlife using ditches<br>- Loss of tidal circulation<br>- Phragmites invasion if freshwater is retained on marsh<br>- Drowning of vegetation if excessive water is held on marsh | - Heavy equipment | P |
| BMP 15. | Remove dredge spoils | - Increase wetland habitat | - Convert low-value upland to more valuable wetland habitats<br>- Eliminate mosquito breeding sites | - Could result in new breeding sites if not carefully designed<br>- Major change in local topography | - Heavy equipment | P |

Please note that other jurisdictions besides NYSDEC may also regulate activities in wetlands.

Table 11. Interim Management/Ongoing Maintenance Actions

| Interim Action | Action | Factors to Consider | Benefits | Impacts | Equipment to be used | General Compatibility with Tidal Wetlands 6 NYCRR Part 661 |
|---|---|---|---|---|---|---|
| IMA 1. | Natural processes (No action reversion) | -Presumptive interim action | - Non-intervention in natural system | - Non-intervention in natural system | - Non-intervention in natural system | - Non-intervention in natural system |
| IMA 2. | Selective ditch maintenance (Standard Water Management) | - mosquito breeding activity<br>- water quality (poor)<br>- improve fish habitat | - Enhance fish habitat<br>- Maintain existing vegetation pattern<br>- Improve fish access to breeding sites<br>- Increase fish and wildlife habitat diversity<br>- Increase biofiltration<br>- Improve fish habitat and access by breaching berms | - Perpetuate ongoing impacts from ditches<br>- Hydrology modification<br>- Minor loss of vegetation<br>- Possible excess drainage of marsh surface | - Hand tools (Minor)<br>- Heavy equipment (Major) | NPN |
| IMA 3. | Culvert repair/maintenance when tidal restrictions are apparent | - improve water quality<br>- restore pre-restriction hydrology<br>-mosquito breeding activities | - Maintain existing habitat<br>- Maintain existing flows and/or prevent flooding | - Continue runoff conveyance into water bodies<br>- Potentially inadequate water transmission | - Heavy equipment | NPN |
| IMA 4. | Stop-gap ditch plug maintenance | - prevent upland inputs<br>- increase wetland habitat<br>- sustain fish and wildlife habitat | - Return to pre-ditch hydrology & vegetation<br>- Reduce pollutant conveyance through marsh<br>- Provide habitat for fish & wildlife using ditches<br>- Retain water in ditch for fish habitat<br>- Deny ovipositioning sites | - Reduce tidal exchange<br>- Reduce fish diversity in ditches due to lack of access<br>- Impoundment of freshwater could lead to freshening & Phragmites invasion<br>- Possible drowning of marsh vegetation<br>- Impermanent approach (likely to fail within 5 years) | - Heavy equipment | GCp |

Please note that other jurisdictions besides NYSDEC may also regulate activities in wetlands.


SUFFOLK COUNTY WETLANDS SCREENING COMMITTEE
FOR INDIVIDUAL MAJOR RESTORATION PROJECTS
PROJECT NOMINATION
• Annual Strategy Plan
• Others, such as:
Landowner
Long Island Wetlands Restoration Initiative
Suffolk County Vector Control
Suffolk County Legislature
CONCEPTUAL DESIGN REVIEW
• Wetlands Subcommittee
• Screening Committee
PRE-APPLICATION MEETINGS
• Permitting Agencies
• Local Representatives and Interested Parties
PROJECT DESIGN
•Suffolk County Vector Control
PERMITTING
• Landowner/Stakeholder
(Potential County Assistance)
IMPLEMENTATION
• Suffolk County Vector Control
MONITORING
• Landowner/Stakeholder
(Potential County Assistance)
Screening Committee Membership
Suffolk County Executive Appointees: (3)
• Commissioner, Suffolk County Department of Planning
• Commissioner, Suffolk County Department of Public Works
• Commissioner, Suffolk County Department of Health Services
New York State Governor Appointees: (2)
• Director, Region I, New York State Department of Environmental Conservation
• Director, Division of Coastal Resources, New York State Department of State
Suffolk County Legislature Appointees: (3)
• Presiding Officer Representative
• Citizen Representative
Towns / Trustees
• Representative, based on project location
Cashin Associates, P.C.
ENGINEERING·PLANNING·CONSTRUCTION MANAGEMENT
FIGURE 2
-LONG TERM PLAN-

## 4.4 Source Reduction Summary

The following table summarizes source reduction efforts under the Long-Term Plan, by focusing on the species of concern identified in Section 1.

Table 12. Source Reduction Summary

| Species | Source Reduction Efforts | Other Issues |
|---|---|---|
| *Aedes vexans* | Upper salt marsh management | Fresh water habitat manipulation contrary to current State regulations |
| *Anopheles punctipennis* | Household efforts | Fresh water habitat manipulation contrary to current State regulations |
| *Anopheles quadrimaculatus* | Household efforts | Fresh water habitat manipulation contrary to current State regulations |
| *Coquillettidia perturbans* | | Fresh water habitat manipulation contrary to current State regulations |
| *Culex pipiens* | Household efforts, storm water structures | |
| *Culex restuans* | Household efforts, storm water structures | |
| *Culex salinarius* | Upper salt marsh management | |
| *Culiseta melanura* | | Fresh water habitat manipulation contrary to current State regulations; habitat often associated with R-T-E species |
| *Ochlerotatus canadensis* | | Fresh water habitat manipulation contrary to current State regulations |
| *Ochlerotatus cantator* | Salt marsh management | |
| *Ochlerotatus japonicus japonicus* | Container, tire management | |
| *Ochlerotatus sollicitans* | Salt marsh management | |
| *Ochlerotatus taeniorhynchus* | Salt marsh management | |
| *Ochlerotatus triseriatus* | Container, tire management | |
| *Ochlerotatus trivittatus* | Upper salt marsh management | Fresh water habitat manipulation contrary to current State regulations |

It is evident from the table that source reduction efforts can reduce populations of many of the species of concern in the County. However, it is also clear that many actions that are allowed in other jurisdictions, such as draining breeding areas and otherwise manipulating fresh water environments, are not permitted under New York State regulations, in order to preserve these environments. In some cases, environmental benefits associated with this general rule are clear. In other cases, the benefits that may result from non-interference in these habitats are not as discernable. SCVC has interest in reported re-evaluations of New York State wetlands

regulations that are said to be occurring within NYSDEC, and would be willing to participate in such efforts, as may be allowable.

# 5 Biocontrols

## 5.1 Introduction

Biocontrols are another alternative for the control of mosquitoes. Biocontrol involves the use of organisms, invertebrate and vertebrate, predator and parasite, some of which have been discussed in sections above. One possible advantage of biocontrol agents is potential host specificity, which implies minimal impacts to non-target species and to the environment. A good example of host specificity is where an introduced organism parasitizes only the target organism, as certain wasp species do with particular crop pests. Such biocontrols would have limited to no impact on non-target species. However, specificity also tends to limit the market for any one biocontrol, as many situations, especially in agriculture, have a number of potential pest species, each one of which would require a specific biocontrol. This specificity and the occasionally large start-up costs deter commercialization and application of biocontrol agents. In addition, other problems include the generally narrow pest control market and, for the user, increased outlays of capital and the associated training required for personnel.

Advantages of biocontrols are generically said to be:

- Reductions in chemical inputs to the environment
- Little or no effect on beneficial and non-target organisms
- Organisms may naturally be a part of the ecosystem, and only require augmentation to reduce pest populations to the desired level
- Possible recycling or establishment of biological control methods to permanently reduce mosquito populations

Disadvantages of biocontrols have been described as:

- Host specific – effective against only one or a few species
- Mass production is difficult
- Generally more expensive initially than conventional methods

- Require trained personnel to assess conditions under which they can be used effectively
- Generally, more difficult to use effectively than conventional pesticides

Most mosquito biocontrols are not species specific. They tend to target all mosquitoes, although they may be more effective on some species as compared to others. In addition, due to the boom-bust nature of most mosquito hatchings, many biocontrols cannot subsist entirely on mosquitoes. This means they have non-target impacts, which more targeted biocontrol-pest situations avoid.

Biocontrols are introduced into the mosquito habitat through two basic procedures: inoculation and inundation. Inoculations introduce organisms in relatively small numbers that reproduce and maintain themselves in the habitat. Population levels may eventually reach equilibrium with the pest population and, thus, provide some long-term control.

Inundation involves the release of large numbers of the biocontrol organism, which is usually a parasite or invertebrate predator, with the aim of immediate reduction of the pest population. Because it is not anticipated that the biocontrol will establish itself in the environment, several inundative releases may be necessary to control the target mosquitoes. The sequence must be repeated if a new brood appears.

Biological control methods fall into six categories:

1) Vertebrate predators (fish, birds)
2) Invertebrate predators (insects, flatworms)
3) Pathogens (bacteria, protozoa, fungi, viruses)
4) Parasites (nematodes)
5) Autocidal (genetic) (not discussed here)
6) Botanicals (plants)

Biocontrols using introduced species have a long history of not achieving desired goals, and in resulting in unintentional impacts that are sometimes worse than the problem that was intended to be addressed. This strongly suggests that extreme care be taken, especially in sensitive settings such as the County's fresh water wetlands, before steps are taken to alter the ecosystem, through biocontrols to reduce mosquito numbers.

Nonetheless, some key potential biocontrols are discussed below.

## 5.2 Vertebrate Predators

Biological control includes the use of many predators, such as dragonfly nymphs and other indigenous aquatic invertebrate predators, including *Toxorhychites spp.*, a predaceous mosquito that eats mosquito larvae and pupae. However, the most commonly used biological control adjuncts are mosquito fish, *Gambusia*. Differences of opinion exist on the utility and actual control benefits derived from *Gambusia* implementation in a mosquito control IPM program. Reports range from excellent control to no control at all. Recently, concerns have been raised over placing *Gambusia* in habitats where other native fish species may become threatened. Care must be taken in placing this species in areas where endemic fish or other species may be impacted. For that reason, the County has considered using fathead minnows as an alternative. Fathead minnows are not native to Suffolk County, but they are ubiquitous and well-established throughout County fresh waters. Still, their use needs to be carefully considered to ensure that no negative impacts result.

It can be very important to preserve environments that have previously been predator free. Vernal ponds are environments that serve important ecological roles because they generally do not support many predators. Natural examples of these pools are usually fed by ground water or snow melt. On Long Island, for example, the ground water table tends to be higher in spring than in other times of the year. This results in vernal pools often drying out at certain times of the year (often summer or fall) and so aquatic life using these ponds needs to find some means of adapting to this situation. One common strategy is to escape the pond environment altogether. Thus, these ponds are often rich in larval forms, and do not contain many mature aquatic life forms. Few fish, for example, can survive the loss of aquatic habitat, and so these ponds host various invertebrates (often including mosquito larvae), and, especially, amphibian larvae that

have developed specialized life cycles so as to exploit this niche, and would probably be preyed upon by any fish. This makes it essential that fish not be introduced where key species reproduce. Stormwater management structures such as recharge basins often serve as admirable vernal pool substitutes in suburban settings. In seeking to control pestiferous mosquitoes, SCVC needs to ensure that it does not introduce fish into previously predator free environments that support amphibians and invertebrates that may be less noxious than mosquitoes.

Birds and bats are often promoted as potential biocontrol agents for mosquito control. While both have been reported to eat adult mosquitoes, they do not do so in sufficient amounts to impact the mosquito populations. Mosquitoes provide such a small amount of nutrition that birds or bats expend more energy pursuing and eating mosquitoes than they derive from them, and so cannot be a primary food source. Additionally, with mosquito flight behavior being crepuscular (most active at dawn and dusk), they are not active during the feeding periods of most birds. While bats are active during the same time periods as mosquitoes, they cannot reduce the massive numbers of adult mosquitoes available.

Purple martins consume large numbers of flying insects, and it was reported that each bird can consume 2,000 mosquitoes a day. Research on the stomach contents of purple martins found that they actually appear to eat much bigger insects (beetles, moths, butterflies, dragonflies, and larger flies). There were no signs of mosquito consumption, and apparently no factual basis for the original report.

There are approximately 45 species of bats in the US. Most bats feed on insects, and so bats are touted as insect controls, especially for pests such as mosquitoes. An oft-quoted figure is that bats eat 600 mosquitoes in an hour. Several large scale efforts have been made to promote bat colonies to reduce mosquitoes. However, the basis of the claim was a limited experiment where starved bats were set in a mosquito-filled room, and ate an average of 10 mosquitoes each over one minute. Extrapolation from this experiment for night-time catch rates of 5,000 mosquitoes per bat are not credible. Although bats are opportunistic feeders, mosquitoes apparently make up only a very small percentage of their diet. Stomach content analyses have found that more typical fare is moths, flies, caddisflies, and leafhoppers (the little brown bat), or beetles, such as ground beetles, June bugs, cucumber beetles (big brown bat), or moths and beetles (Mexican free-tailed bat). In addition, increasing bat populations carries added risk of bat-associated

rabies. In the last 40 years, most human cases of rabies in the US have resulted from bats. Rabies is almost always fatal, and the CDC recommends "prevention of human exposure" to bats as a means of reducing the risk of catching the disease.

It seems that predators touted as mosquito catchers may prefer to consume larger prey that offer greater reward for the capture effort. In addition, since consumption of mosquitoes will not be capable of sustaining any augmented predator population (especially if control of brooding mosquitoes is sought), the ecosystem must have additional resources to support the predators. This may mean dislodging some other local predators from their ecological niche.

### 5.3 Non-vertebrate Control Agents

The yeast-like fungus *Lagenidium giganteum,* has been used for mosquito control in still water environments. It attaches to and penetrates the mosquito larvae, then grows inward, eventually filling the body cavity, causing death. It is then released, where it can form more zoospores that can infect other larvae. The parasitic nematode *Romanomermis culicivorax*, the pathogenic protozoan *Nosema algerae*, and some non-digestible algae have been examined as biocontrol agents by university, government (USDA), and by mosquito control organizations, with mixed results.

Another group of biocontrol agents with promise for mosquito control is predaceous copepods. Copepods are easy to rear and to deliver to the target sites in the field, and they generally perform well when used with pesticides. However, they have not been shown to provide the degree of control that comes with other biocontrols such as fish. Copepods must multiply to effectively attack mosquito larvae populations, leading to a lag time between inoculation and effective control. There is some County interest in developing a copepod program in Suffolk County as some species may be effective for long-term control in catch basins. In areas with seasonal rain patterns, brine shrimp have also shown promise as similar larval predators.

Rotenone and pyrethrum are plant products that have a long history in pest control. Pyrethrum is discussed in Section 7, Adult Control. Substances released from bladderwort (*Utricularia*), stonewart (*Chara*), and duckweed (*Lemna*), are known to be toxic to mosquito larvae. Extracts from an alga (*Elodea nuttallii*) and a sage brush (*Artemisia cana*) are highly toxic to immature mosquitoes. Data have not been collected as yet regarding their efficacy on different mosquito

species and selected non-targets. The mode of action for most of these toxicants remains unknown.

Dragonflies are predatory insects that catch midges, mosquitoes, small moths, and even bees and butterflies. The use of dragonflies to control mosquitoes has been used in the town of Wells, Maine, where dragonfly augmentation was incorporated into their mosquito control program. The Town raises and sells dragonfly nymphs to local individuals who want to use them on their property. Dragonflies are difficult to rear in the laboratory for release, and they have a very long life-cycle, meaning populations cannot be quickly increased. In addition, dragonflies are free to fly about and therefore cannot be contained in the area where control is desired. Dragonflies do, in fact, eat mosquitoes, and, therefore, reduce local mosquito populations to some extent. The determination of the effectiveness of dragonflies in Wells is complicated by the Town's concurrent use of Bti. The apparent success of the dragonfly release program could be due to larviciding. In New York State, there is only one species of dragonfly that utilizes salt marshes. Some dragonflies in fresh water marshes synchronize hatching to coincide with springtime mosquito emergences. This is one of the few instances of any known direct ecological links between mosquitoes and another species.

# 6. Larval Mosquito Control

## 6.1 Background Information

Larviciding is a general term for killing mosquitoes by applying natural agents or commercial pesticides to control the larval and pupal stages of the organisms. Since both of these life stages are exclusively found in aquatic environments, larvicides are always applied to water. Larvicide treatments can be applied from either the ground or air. Larviciding, originally implemented as a malaria control procedure in the early 1900s, has become a mainstay of mosquito control over the years. As populations of larval mosquitoes are more concentrated in limited geographical areas, the portion of the environment that needs to be treated is less than when targeting adult mosquitoes.

Safely altering aquatic environments, even temporarily, for the purpose of controlling mosquitoes requires a good working knowledge of both the target species and larvicides. Mosquito control now approaches prescription applications, where a competent operator will apply one or more larvicides in an environmentally sound manner under a given set of conditions to address particular species and ages of larvae.

The Long-Term Plan proposes to use three biorational products as its primary larvicidal treatments. These three products, *Bacillus thuringenesis var israelensis* (Bti), *Bacillus sphaericus* (Bs), and methoprene, have been shown through the risk assessment to have no impacts to human health, and apparently no significant or substantial impacts to the environment.

These conclusions are supported by independent scientific experiments conducted by the Long-Term Plan, and a rigorous review of the scientific literature. It is a general objective of the Long-Term Plan to avoid the use of pesticides, whenever possible. It is a basic tenet of IPM that an excessive dependence on pesticides is not wise from a programmatic point of view. An excessive reliance on pesticides can make a program vulnerable to control failure. For instance, logistical problems or weather conditions may prevent the application of pesticide in all areas where they are needed and at the proper times. Development of resistance to pesticides to the targeted organisms can be a problem. In addition, if a widely used material is found to have unacceptable impacts, or if it becomes unavailable due to market forces, a program that is overly

dependent on that material can find itself without viable options. Sound management principles dictate that pesticides must be just one part of a comprehensive control program. These management principles result in a long-term plan that emphasizes water management as a means of reducing larvicide applications. Scientific surveillance measures are the means of ensuring that larvicide applications are truly necessary. Surveillance data analysis to establish site-specific values for dipping results may allow for further reductions in larvicide applications. These measures should be taken despite the Long-Term Plan's determination that larvicide applications have no apparent human health or environmental impacts of substance or significance.

Fresh water wetlands require special consideration for any pesticide treatment. These environments are more diverse than salt water mosquito breeding sites, and have the potential to be more sensitive to perturbations. Most of the species of special concern in the County are found in or near fresh water wetlands. Therefore, the County will, over time, through consultation with State, County, and town natural resource staff and other interested parties, develop GIS determinations of the fresh water areas that require more nuanced approaches to treatment decisions. A focus will be on the identification of vulnerable species, and to determine the points in their life histories that may make them more susceptible to potential impacts from vector control operations, and then to determine what modifications of vector control activities can be made to mitigate the potential impacts. For instance, because of special reproduction requirements for certain species, spring or early summer pesticide treatments may be counseled against. In other instances, early morning or evening applications may be preferred in order to avoid knock down by sprays of day-active insects. These plans may become customized for particular settings. An expansion of GIS capabilities in the County may facilitate this approach. As inventories of the wetlands and the special habitat and other needs of important species are ascertained, special research conducted on behalf of the County may be able to craft modifications of its standard operating procedures to reduce the chances that any negative environmental impact will follow from treatments. As an important example of this, following consultation with NYSDEC, SCVC has removed all tiger salamander habitats from its larvicide list, to ensure that no possible impact from these pesticides to this rare species can occur.

### 6.2 Surveillance

All treatment decisions will be made on the basis of scientific surveillance to determine the need for the treatment. In the case of larvicide applications, appropriate surveillance requires sampling for the presence of larvae. Although standardized sampling methods have been developed (and discussed in the scientific and technical literature) for larval sampling of all kinds, the results of the testing are almost all sampler-dependent. Dipping, the standard open water technique, requires learning to approach the water systems so as not to startle the larvae, and/or to comb through fringing vegetation. This increases the likelihood that different samplers will capture different numbers (and, potentially, different species) of larvae. Catch basin sampling has not been as standardized, but also seems likely to be dependent on some degree of sampler skill in identifying the proper level to scoop larvae from, and to execute the sampling run consistently. Some programs report larval sampling quantitatively, and report the results as measures of effectiveness or as a relative risk measure; it is far from clear that the necessary accuracy and precision to conduct that kind of analysis is associated with the sampling techniques. For example, on a salt marsh, breeding often occurs in small potholes at or near to *Spartina patens* (salt hay). Numbers of larvae per dip under these conditions can be extraordinarily high. However, the same number of larvae, if dispersed through a panne area, will generally have a lower number of larvae recorded per dip because of the larger area over which the larvae might be spread. For salt marshes, presence/absence and the proportion of the marsh that appears to be breeding (due to the extent of the tidal flooding) are much sounder means of estimating the potential for adult mosquitoes.

SCVC has had good experience using a larval dipping index at Wertheim National Wildlife Refuge. However, at that site, the same sampling crews tended to repeat measurements at consistent locations. Much of the larval sampling in the SCVC program is in response to complaints, and so necessarily requires sampling in disparate areas. Also, the trigger value set for Wertheim larviciding was determined post-facto; analysis of sampling data showed that if a particular value for the trigger were to be used, it would eliminate a certain number of larval treatments. Prior to setting the trigger value, SCVC had determined that the neighboring community might not suffer from excessive numbers of mosquitoes if some of the larviciding treatments had been reduced at Wertheim. As treatments could not be entirely eliminated, using

a particular mean number of larvae per dip that resulted in a reduction of larvicide treatments by approximately 25 percent should not result in excessive community impacts. This is somewhat of a unique situation, since the distance from the treatment sites in the National Wildlife Refuge is greater than the distance is for most salt marshes to surrounding houses.

Therefore, generally SCVC will continue to rely on absence/presence tests of larval habitats at this time. Qualitative assessments by samplers of relative population densities (none-some-many-throngs) will be used as a determinant of apparent populations. Samplers will also record actual numbers of larvae, as possible, per dip. For the identified breeding locations, data analysis of these numbers will be pursued, and it may be that site-specific triggers that appear to lead to reasonable reductions in larviciding frequencies can be developed over time. Samples will be collected for laboratory speciation, as well.

Until site-specific triggers are established, however, the determination of a need to control larvae will be the identification of a potential mosquito problem. This is determined by complaint history, close association with residential or recreational settings, or disease history or other risk factors, and the presence of human-biting mosquito larvae. The presence of human-biting mosquito larvae is a determination made most often by observations through sampling with identification of the larvae as a pest species by field crews, or by the subsequent laboratory analysis of the returned specimens.

Permanent and transient fresh water breeding habitats have also been identified and catalogued by SCVC. The permanent water sites are visited on a regular basis. Transient water sites, which are not as extensive in Suffolk County due to the high permeability of the soils (generally) are sampled following significant rain falls. History dictates the kinds of rains likely to produce breeding. It has been suggested that establishing a trigger value for permanent water sites is possible; again, this needs to be determined through correlation of the number (and kinds) of larvae that later result in adult mosquito population problems. These computations are likely to be site specific, as larval density is not consistent across habitats, and so the selection of a County-wide trigger value would be arbitrary.

### 6.3 Mosquito Problem Identification

There are four types of areas where SCVC may apply larvicides. They are:

- catch basins and other, mostly underground, storm water control structures;
- sites identified by complaints (mostly household-institutional sites);
- breeding areas within marshes that are aerially larvicided;
- breeding areas that are not within marshes that are aerially larvicided.

*Storm water structures*

Some storm water structures have been identified as potential breeding problems by SCVC through surveillance work. There are approximately 10,000 such structures that currently receive applications of long-lasting larvicide products. SCVC proposes to expand its surveillance of catch basins so that another approximately 40,000 sites are evaluated in the first year of the Long-Term Plan. It is estimated that there are 100,000 catch basins in the County, although the actual amount is unknown. These sites will be prioritized first by age. An assessment of some systems by Cashin Associates suggested that older systems, due to a greater likelihood of poor maintenance, are more likely to hold water and therefore breed mosquitoes. Where possible, maintenance records and plans of appropriate agencies, typically, SCDPW or town and village highway departments, will be accessed prior to the surveillance effort. Recent cleaning generally means that the system will not hold water, and cleaning plans will mean that treatments will be wasted as the larvicide material would be removed in cleaning the basin. If the basin shows signs of breeding, it and all connected basins will be treated to limit the risk of potential mosquito disease transmission. *Cx. pipiens* is the dominant mosquito species in catch basins, and has been identified as the major WNV disease vector for Suffolk County.

Open water systems, such as recharge basins, without histories of treatment will be assessed similarly to environmental sites identified in complaints.

*Sites identified by complaint*

Most complaint call investigations are easily resolved by identifying household breeding sites, and remediating them. These kinds of problems, such as gutters that retain water, open containers, bird baths, wading pools, pool covers, etc., can be treated by removing the water (and the cause of the water accumulation, such as turning a bucket upside down, or recommending gutter clean out) without needing any pesticide applications. In some situations, the household mosquito source is too large, such as a poorly maintained above or below ground pool or impossible to treat like a cesspool. In those instances, treatment with a larvicide may resolve the immediate problem, and allow time to investigate for long-term management of the underlying problem.

In other complaint situations, the source of the troubling mosquitoes may appear to be an environmental setting, e.g., a local wetland area. If the wetland is a known breeding area subject to regular surveillance, then the appropriate problem determination procedure will be followed, as detailed below. Such sites will be identifiable by the vector control crews as they respond to complaints in areas that they generally are familiar with from surveillance activities. In addition, all known breeding sites are mapped and available through GIS, allowing the team to quickly identify in the field, whether the complaint is originating from an existing breeding site. If the site is not a known breeding site, then sampled larvae will be brought to the laboratory for official identification, and follow-up at the site shall be undertaken by senior level staff.

Options available on this follow-up include minor water management to resolve a drainage or fish access issue, larvicidal treatment, or assignment to a follow-up surveillance list. The determination as to whether to treat the site will be through evaluation of ecological issues and the degree of seriousness of the problem. If the site is obviously an area where species of concern are likely to be found, or the life cycle of a particular organism of interest suggests that at particular times of the year it may be more at risk, or it is in an area (such as the Central Pine Barrens) predetermined to be of environmental concern, treatment may be deferred, unless the scope of the problem appears to require immediate action. The senior staff will annotate the SCVC GIS with appropriate treatment trigger information, including quantitative or qualitative larvae presence factors, time of year, or other issues of note. As described above, these kinds of

determinations will be generated through consultation with State and town natural resource staff, and interested parties, and through targeted research sponsored by the County.

*Aerial larviciding sites*

Sites that are considered for aerial applications of larvicides are those that are too large or inaccessible for ground application and breed mosquitoes consistently and persistently. There are approximately 4,000 acres of salt marsh that receive aerial larviciding at this time. A major focus of the water management plan is to substantially reduce this acreage. However, it will require time to implement the physical changes to the marshes that will result in better water management and predation by native fish on the larvae. It has been the experience of other jurisdictions that progressive water management generally leads to elimination of the need for regular larviciding.

Until those projects have been undertaken, the sites will be monitored weekly by SCVC crews. Testing in the salt marsh will be on a presence/absence basis, with identification of the larval stage included to guide pesticide choices. Almost all mosquitoes found on these marshes at the peak of the season are *Oc. sollicitans*, although other species dominate in spring (*Oc. cantator*) or are a substantial presence later in the season (*Oc. taenorhynchus*), and others are sometimes detected (most often through laboratory identifications). Use of GPS equipment will allow for good determinations of the portion of the marsh that is breeding. Field observations regarding the intensity of breeding will also be useful for decision-makers. In addition, the state of the tide and the status of water on the marsh may be used in making treatment decisions. If weather forecasts suggest the breeding habitats will dry down prior to any adult emergence, then the need to larvicide has been removed.

It may be that a careful analysis of treatment histories and subsequent adult mosquito infestations suggest that a certain amount of larvicide treatments can be eliminated for some of the marshes. Then analysis of larval survey records may help determine some kind of threshold value for each particular marsh, probably based on a mean number of larvae per dip. However, until such values are established, SCVC will continue to rely on presence/absence determinations as a sign of excessive breeding in the salt marshes.

*Breeding sites not aerially larvicided*

There are other breeding locations that are regularly monitored by SCVC. These are wetlands that do not require aerial treatments, either due to their small size or relatively minor mosquito problem. The kinds of mosquitoes that can be expected to be found at these sites have been well determined over time. Therefore, field crews can often make treatment decisions based on sampling results, and efficiently treat any problem that is brewing.

Fresh water sites on this list are good candidates for reassessment of routine treatment measures. It will be important to factor into the decision-making regarding such sites that the control of bridge vectors probably plays an important role in the prevention of EEE County-wide, and so it is unlikely that major breeding sites for known EEE vectors will be allowed to flourish without intervention. Nonetheless, as with the frequency of larviciding in certain salt marshes, some of these fresh water sites may be places where treatment patterns can be altered to ensure that there are no non-target impacts to important elements of the ecosystem.

### 6.4 Larval Treatment Selection

The choice of methods for larval control is based on several factors:

- Species of mosquito present
- Kind of habitat to be treated
- Stage of larvae present
- Efficacy of the considered treatment
- Residual effects (potency and duration)
- Potential environmental impacts of the considered treatment
- Resistance management

The selected larvicides, Bti, Bs, and methoprene, all tend to score well in each of these areas. Some other pesticides do not rate as well, and so their use was not preferred.

Most larvicides are effective against all mosquitoes. This is true although the range of action of larvicides has been generally reduced compared to that of broad spectrum insecticides. Methoprene, as an example of a more modern pesticide with a narrow range of action, generally is lethal only against members of Diptera (true flies). Diptera includes mosquitoes.

Species composition is important for gaining some understanding of breeding patterns. For example, if the larvae belong to a univoltine, brooding mosquito, generally long acting pesticides would be wasteful as there will be no further breeding once this episode passes. For multivoltine, steady-breeding mosquitoes, it is not important to know what stage is currently dominant, as breaking the breeding cycle is more important. For brooding, multi-voltine mosquitoes such as *Oc. sollictitans*, knowing what stage the current brood is in becomes very important, so as to disrupt what may be a large emergence. Therefore, identifying the species of mosquito that is breeding is important.

Certain larvicidal compounds are effective only in open water; some lose effectiveness if there are too many particulates in the water; some are best for permanent bodies of water, while others have extensive environmental requirements in order to be effective. One extreme example of requiring certain conditions for larvicidal action is brine shrimp, which are used in certain kinds of agricultural fields in California, and need to undergo special cycles of drying, wetting, and to experience certain temperatures to hatch and then consume mosquito larvae. Another example is surface films, which are best suited for prevention of breeding over expanses of open water that are relatively still and do not have extensive amounts of vegetation. Where such conditions do exist, a relatively small access point can allow for coverage of large amounts of acreage, because the products tend to spread very well. Environments that are well suited for such products are relatively few in Suffolk County, and so the use of monomolecular surface films is not expected to be significant.

Bti and Bs need to be ingested to be effective. This limits their utility to Stage I, Stage II, and Stage III larvae. In the salt marsh, Bti seems most effective on stages I and II, when the marsh is very wet, and when temperatures are relatively low. If these pesticides are considered for use, then they either need to be applied to situations where they will eventually choke off further breeding, or where most of the current mosquitoes will be directly affected by them.

Applying products that will not achieve the desired end is not only wasteful, but violates the prime tenet to avoid pesticide use wherever possible. Bs, Bti, and methoprene have all been demonstrated to be generally effective, although there are some limitations due to acceptable environmental conditions for Bti. Testing of the compounds has shown order of magnitude or more reductions of potential populations due to their applications. Suffolk County-specific data showed that adult salt marsh mosquito populations were reduced by nearly another order of magnitude when methoprene was added to a Bti-based larviciding program in 1995. Some of the other compounds SCVC has been urged to adopt do not have clear demonstrations by disinterested parties that they are effective.

A certain degree of residual effect for a targeted pesticide appears to be a favorable characteristic. However, the lessons of the very long-lived post World War II pesticides is that compounds that degrade slowly may have unexpected environmental impacts. Therefore, most of the longer-lived larvicides are that way because of natural actions (Bs, as a bacteria, propagates in nature under certain conditions) or because the application has been treated to slow release of the pesticide to the environment from its packaging (time release formulations). This eliminates the need for the program operator to be as precise in the timing of applications as might otherwise be necessary. It also allows for the pesticides to impact species effectively when not all eggs mature at the same time (as with *Cx. pipiens*). A danger of time release formulations is that the released concentration may not be high enough to effectively kill all of the dosed larvae. This can lead to resistance in such partially-treated populations. For this reason, SCVC will not be using some of the longest-lived time release formulations (instead, multiple does of shorter-lived formulations will be used to ensure coverage over a season).

Potential environmental impacts associated with control measures are important factors in selecting agents to be used. The selected agents, Bs, Bti, and methoprene, have long research histories that generally find no to little non-target impacts. The ecological risk assessment analysis conducted for the Long-Term Plan found little likelihood of ecosystem impacts from these chemicals, and research conducted as part of the project (such as invertebrate surveys of larvicided marshes and follow-up work associated with the Caged Fish experiment) also did not detect larviciding impacts to marine invertebrate communities.

Other larval controls do not have as robust histories of research for potential impacts. Particularly, the monomolecular films generally have fewer independent studies to determine any impacts to non-target organisms. Monomolecular films are not as targeted control mechanisms, and so may a potential to result in non-target effects.

Some controls have been extensively studied, but have been found to potentially have greater impacts on the environment than the selected agents. Temephos falls into this category. However, because temephos does not have a New York registration, it did not receive extensive consideration for inclusion as a larvicide for the Long-Term Plan.

One other alternative to pesticidal larval control has been touted. New Mountain Innovation Company has produced a Larvasonic acoustic device, which is expected to kill larvae using sound energy. The device gives off sonic energy as a short (less than 15 seconds), minimal energy burst of about 400 watts that causes air spaces within each larvae to resonate violently enough to kill them by disrupting internal membranes and organs. There are several adaptations of the technology:

- a hand-held unit, about the size and shape of a weed-eater, for ditches and wetlands,
- a canal-pod unit to be towed behind a boat in canals, and
- a storm drain unit.

These devices are expensive ($4,000 and up) and are limited in their "killing power" to a range of three to 25 feet in diameter, corresponding with the model being used. In addition, controlled laboratory testing against other closely related non-target aquatic insects or other invertebrates has been limited; and there has been only limited field testing so far. Testing against larvae in a wading pool found the machine killed *Cx. pipiens* larvae better than expected, but did not succeed with *Oc. triseriatus* larvae. Perhaps the most important consideration limiting the use of the Larvasonic device is the fact that it only kills the larvae present at the time the device is used. In this way, it is similar to the short-acting biological larvicide, Bti. Given that there are few ecological reasons to limit the use of Bti, it is not clear that there is any environmental benefit to be gained from the use of this costly device. It may have uses in permanent installations such as in sewage treatment plants. The main advantage of the Larvasonic is that it is not regulated as a

pesticide. This may make it an attractive alternative for small-scale programs that are not prepared for the efforts needed to comply with pesticide regulations.

Resistance to control is always possible. One reason for the County to use multiple larvicide products is to allow for resistance management. The County tends to alternate between Bti and methoprene in salt marshes, for example. Bti is effective with Stage I, Stage II, and Stage III larvae, so when development is slower in spring and later summer, Bti is preferred. Methoprene prevents larvae from developing, and is a contact pesticide; so it is effective for all stages of larvae, especially late stages. It is used when larvae are developing quickly, as the lag between detection of larvae in the marsh and treatment with Bti in summer could result in ineffective treatments, as no susceptible organisms would remain because they had all become Stage IV or later organisms. This suggests that methoprene may be a more effective larvicide overall than Bti, and indeed County records show large improvements in larval control efficiencies when methoprene was introduced in 1995. However, reliance solely on methoprene could run a considerable risk of developing resistant mosquitoes, by eliminating all mosquitoes except those that methoprene does not kill. Bti uses five distinct toxins to kill mosquitoes; it is generally believed that so many toxic compounds will not allow for resistance to develop, and so from that standpoint Bti has advantages. It has been SCVC's experience that using both these materials has resulted in a more effective program than would be possible if only one of either is used. By having Bti and methoprene available for use, SCVC is able to use each of them under the conditions where they are more likely to be effective.

The County will also use a duplex formulation of Bti and methoprene in summer when generations appear to be overlapping, or development is especially rapid. This can also aid in resistance management to either material should any occur, since it is unlikely that mosquitoes can develop resistance to both products simultaneously.

In sum, the selection process found that the pesticides Bs, Bti, and methoprene should be chosen for use due to the advantages in control that they present, and because they do not have certain disadvantages associated with other larval products.

### 6.5 Selected Compounds

*Bacillus thuringiensis israelensis (Bti)*

Bti is a naturally occurring soil bacterium used as a microbial pesticide. Microbial pesticides are comprised of microscopic living organisms (e.g., bacteria, fungi, protozoa) or the toxins produced by these organisms. Bti is used to control the filter feeding stages of mosquito, black fly, midge, and fungus gnat larvae. Granular and liquid formulated products can be applied through ground or aerial application. Bti is commonly registered under the trade name VectoBac and Teknar. These materials consist of bacterial spore, rather than live bacteria, and must be ingested by the larvae to be effective.

Bti's selectivity in terms of its ability to target the larvae of certain insect species, particularly mosquito and black fly larvae, is attributable to a variety of factors. Bti produces five distinct types of endotoxins. Targeted insects are less likely to build up resistance to Bti because each of the five produced toxins varies to some degree in its mode of toxicity. Alkaline conditions in the larvae's gut, generally corresponding to a pH of seven or greater, are required to activate these endotoxins. Specific enzymes must also be present in the gut to cause activation. In addition, distinct chemical receptors must be present in the plasma membrane of the gut to encourage binding of the endotoxins. Mosquitoes that are most susceptible to Bti include species in the genera *Aedes* and *Psorophora*. *Anopheles* and *Culex* are also susceptible to Bti, but generally higher application rates are required.

The World Health Organization (WHO) has concluded that because of the specific nature of the mode of action of Bt products, they are unlikely to pose a health risk to humans or other non-target animals, as long as they are free of exotoxins or other non-Bt microorganisms. This conclusion is supported by the lack of reports of adverse health effects in workers who manufacture Bt products. The protein involved in the pesticidal activity of Bt (Cry3Bb1) has been tested and shown not to produce toxicity in mammalian species.

USEPA does not consider Bti to be a risk to non-target organisms, on principle. Nonetheless, the behavior of Bti, and Bt strains in general, has been fairly well studied. The length of time that Bti remains effective against insect larvae varies, depending primarily on the species and

behavior of the larvae, environmental conditions, and water quality. In general, Bti is effective from one to seven days after application. Because Bti is used predominantly in aquatic settings, its response to light has not been extensively studied. However, UV light in the range of 300 – 400 nanometers (nm), falling within the wavelength range of sunlight, has been shown to inactivate both spores and endotoxins of Bt. Bti toxin can last for a few months in the soil and has an above-ground half-life of one to four days on plant surfaces. As a result, exposure to most above-ground non-target organisms is expected to be minimal. In aquatic environments, Bti has a tendency to bind to particulate matter in the water column and settle out on the bottom. When adsorbed to particulates in the water column, Bti is too large to be ingested by insect larvae. Once settled on the bottom, Bti is not available for consumption by targeted mosquito and black fly larvae which reside in the open water column or at the water's surface. Thus, the efficacy of Bti may be limited in aquatic systems with a large amount of particulate matter.

Bti, as is the case with Bt strains in general, does not colonize or cycle (reproduce and persist to infect subsequent generations of pests) in the magnitude necessary to provide continuing control of target pests. The bacteria may multiply in the infected host, but bacterial multiplication in the insect does not result in the production of abundant spores or endotoxins. Once larvae die, few or no infective units are released into the environment.

There is some evidence of Bti effects to non-target aquatic dipterans that include midges (Chironomidae), biting midges (Ceratopogodinae), and dixid midges (Dixidae), which are commonly associated with mosquitoes within the aquatic environment. These organisms are taxonomically similar to mosquitoes and black flies and can possess the gut pHs and enzymes necessary to activate Bti's delta-endotoxins. Adverse effects to these groups, however, have only been noted at dosages 10 - 1,000 times greater than the application rate specified for mosquito control.

Overall, USEPA has concluded that Bti does not pose significant adverse risks to non-target organisms or the environment, especially since rates higher than those used for vector control are needed to produce any adverse effects. Bti has been used by SCVC since 1982, SCVC was one of the first programs in the US to use this material on a wide scale.

*Bacillus sphaericus* (Bs)

Bs, as with Bti, is a naturally occurring bacterium used as a microbial pesticide. Bs is found naturally in soil and aquatic environments. Commercial formulations utilizing Bs (e.g., VectoLex) consist of living bacterium that produce spores. Granules that contain the Bs are mixed with water and other substances, and then sprayed from the air or from the ground.

Bs spores produce two delta-endotoxins that are toxic specifically to mosquito larvae upon ingestion. Similar to the mode of action of Bti, Bs exerts toxicity through the release of the endotoxins upon ingestion by mosquito larvae, which results in the disruption of gut activity and ultimately leads to death. The selectivity of Bs is attributable to the fact that certain gut conditions (i.e., pH, enzymes, chemical receptors) unique to mosquito larvae must be present to result in toxicity. Bs has been shown to be effective against many mosquito genera. All species of *Culex* larvae are considered susceptible to Bs, and many species of *Aedes*, *Psorophora*, *Coquillettidia*, *Mansonia* and *Anopheles* are also very susceptible. However, susceptibility of species within these genera is variable. Studies of Bs clearly indicate that it is not infectious or pathogenic.

USEPA does not require formal environmental fate data for Bs given its nontoxic nature to non-target organisms. The length of time that Bs remains effective against mosquitoes varies, depending primarily on the species and behavior of mosquito larvae, environmental conditions, and water quality. In particular, Bs appears to recycle in the cadavers of dead mosquito larvae. This means that, in general, the more larvae that are killed in the initial application, the longer the residual action. In general, Bs is effective for one to four weeks after application, although measures of effectiveness range from as little as 2.5 hours to more than 60 days. UV light in the range of 300 – 400 nm, falling within the wavelength range of sunlight, has been shown to inactivate both spores and endotoxins of Bs. Bs is less likely than Bti to adsorb to particulate matter and settle out of the water column. Therefore, it is considered to have generally higher efficacy against mosquito larvae in waters with a higher degree of particulates. As it occurs naturally, Bs does cycle and maintain itself in the environment; however, the insecticidal formulations currently in use do not cycle in salt water to infect subsequent generations of mosquito larvae (but will in fresh water). Bs is relatively slow acting, compared to Bti. Larvae

in a treated area may hatch, and develop through the first two larval stages prior to being controlled. For this reason, once an area has been treated, it should not be re-treated unless stages III and IV are present. SCVC field crews have been specially trained to understand this effect in order to avoid unnecessary re-treatments.

Bs is generally not considered a risk for non-target organisms. The commercially available form of *Bs*, VectoLex, has been extensively tested and is considered non-toxic to non-target organisms. USEPA concluded that Bs does not pose any significant risk to non-target organisms or the environment. Bs has been used by SCVC since 1997. It is particularly favored by the field crews, who have observed firsthand that the sustained action of this material saves them work by requiring fewer re-treatments.

*Methoprene*

Methoprene is a biochemical pesticide found in two formulations (methoprene and methoprene sustained release formula) and is registered under the Altosid trade name line. Methoprene is used to control mosquitoes, beetles, horn flies, tobacco moths, sciarid flies, fleas (eggs and larvae), fire ants, pharoah ants, midge flies, and Indian meal moths. It is also registered for use on a number of foods including meat, milk, eggs, mushrooms, peanuts, rice, and cereals. There are also uses in food processing plants and eating establishments; along with non-food uses such as for tobacco, ornamentals, golf courses, pet products, uses in and around the home, and in boxcars.

Methoprene is an insect growth regulator that acts by interfering with maturation and reproduction in insects by mimicking the activity of natural juvenile insect hormone. This hormone in insects, secreted by glands near the brain, controls the retention of juvenile characteristics in larval stages. If present, it (or methoprene acting as an insect growth regulator) leads to a suppression of adult characteristics. Although applied at the larval stage, response to methoprene usually occurs in the last instars of the larval or nymph form, or pupae form. In the case of mosquitoes, larvae are the target stage, but the effect is not seen until lack of adult emergence.

Methoprene degrades rapidly in sunlight, both in water and on inert surfaces. Within three days of application, 90 percent will degrade via photolysis and microbial metabolism; without

microbial metabolism, photolysis will degrade 80 percent in 13 days. Overall, methoprene has a half-life ranging from 30 hours to 14 days, depending on environmental conditions. Higher temperatures and salinity lead to higher degradation rates. The effects of methoprene last up to a week, but it reaches undetectable levels in ponds within 48 hours of application. After four days, only one percent of the original application concentration will persist in the top two inches of soil. Methoprene is tightly adsorbed to soil and is rapidly broken down; therefore it is not likely to be transported to ground water. Methoprene sustained release formulation does not produce residual concentrations greater than those produced with the application of the liquid formulation. Sediment sampling associated with the Caged Fish experiment suggested that methoprene has a half-life in sediments of approximately one week.

Methoprene is generally considered to be slightly to non-toxic to terrestrial wildlife. Methoprene is considered slightly toxic to birds. Methoprene may have some impact on honeybee foraging, although definitive data are pending. When methoprene is used as a mosquito larvicide, honeybees are unlikely to be exposed to the product, as it is applied so as to affect mosquito larvae in aquatic settings, and not bees concentrating on collecting pollen.

Methoprene is considered moderately toxic to warm water, freshwater fish, and is slightly toxic to cold water, freshwater fish. Methoprene is considered highly toxic to freshwater invertebrates. For amphibians, mortality has not been observed at concentrations up to 1.3 ppm (leopard frog). However, adverse effects such as reduced body weight and developmental delays at 720 ppb (leopard frog) were observed. In recent years, methoprene has received considerable attention as a possible causative agent of the increase in amphibian malformations. The theory that methoprene might mimic the action of retinoids and cause malformations in amphibian populations is partially supported by research on how methoprenic acid (t-MA) can stimulate gene transcription in vertebrates, particularly amphibians during metamorphosis. Much of this theory, however, remains largely unsupported by ancillary information and anecdotal reports, as well as contradictory findings within and outside of the taxon. Research in this area is considered ongoing and future experimental findings and other developments warrant attention.

At sufficient concentrations, methoprene can be very highly acutely toxic to estuarine and marine invertebrates, as seen in studies with grass shrimp and mud-crabs. However, this toxicity was observed at levels far greater than those that result from mosquito larviciding. Marine organisms

are not likely to be exposed to methoprene, but estuarine organisms are likely to be exposed as a result of application within estuarine habitats. Methoprene degrades rapidly in water so the use of most formulations in estuaries is generally not of concern. However, concern has in fact been raised in recent years with respect to methoprene's potential impact on shrimp, crabs and lobsters. These concerns stem from the fact that a shared evolutionary past, as well as resultant similarities in biology, exist between crustaceans and dipteran species (including mosquitoes). These concerns were heightened by events such as the widely-publicized 1999 Long Island lobster die-off, although subsequent studies have indicated environmental and not chemical causes. Most of the recent studies of estuarine invertebrates have used shrimp, Atlantic oysters, amphipods, copepods, and mud crab. In general, impacts to these species are not anticipated to occur at expected environmental concentrations. The Caged Fish experiment found no impact to exposed fish and shrimp, for example. The risk analysis found no risks for impact to ecosystems because exposures were much less than the levels required to cause impacts to organisms. Methoprene has been used by SCVC since 1995, and is particularly useful in the salt marsh, where Bti is not always effective.

### 6.6 Formulations and Uses

There are five basic Bti formulations available for use: liquids, powders, granules, pellets, and briquets. Liquids, produced directly from concentrated fermentation slurry, tend to have uniformly small (two to 10 micron) particle sizes, which are suitable for ingestion by mosquito larvae. Powders, in contrast to liquids, may not always have a uniformly small particle size. Clumping, which results in larger sizes and heavier weights, can cause particles to settle out of the feeding zone of some target mosquito larvae, preventing their ingestion by the typical filter feeding process used by these insects. Powders must be tank-mixed before application to an inert carrier or to the larval habitat. They must be mixed thoroughly to achieve a uniformly small consistency. Bti granules, pellets, and briquets are formulated from Bti primary powders and an inert carrier. Bti labels contain the signal word "CAUTION" (see Appendix 2). SCVC will predominantly use liquid and briquette formulations.

Available commercial brands of Bti liquids include Aquabac XT, Teknar HP-D, and Vectobac 12AS. Labels for all three products recommend using four to 16 liquid oz. per acre in unpolluted, low-organic water with low populations of early instar larvae (clean water

situations). The Aquabac XT and Vectobac 12AS (but not Teknar HP-D) labels also recommend increasing the range from 16 to 32 liquid oz. per acre when late third or early fourth instar larvae predominate, larval populations are high, water is heavily polluted, or algae are abundant. Bti liquids will be applied by air or truck, with or without methoprene in a duplex formulation.

Bti briquets (donuts) are a mixture of Bti, additives, and cork. They are designed to float and slowly release Bti particles to the water body for extended periods of time. They apparently are attractive to raccoons because of their odor, and may sometimes be disturbed or carried off (other wildlife may also feed on them). Donuts may be staked in place to prevent wind from moving them from a site's littoral zone into open water. The use rate is one donut per 100 square feet in clean water and up to four donuts per 100 square feet in dirty water. They are available for use in recharge basins, pools, and, potentially, catch basins, although the difficulties associated with highly organic water make these somewhat less preferred than either Bs or methoprene.

Corncob granules use a carrier that is dense enough to penetrate heavy vegetation. There are currently two popular corncob granule sizes used in commercial formulations. Aquabac 200G, Bactimos G, and Vectobac G are made with 5/8 mesh size grit-crushed cob, while Aquabac 200 CG (Custom Granules) and Vectobac CG are made with 10/14 mesh size grit cob. Aquabac 200 CG is available by special request. The 5/8 mesh size grit is much larger and contains fewer granules per pound. The current labels of all *Bti* granules recommend using 2.5 to 10 lbs. per ac. in clean water and 10 to 20 lbs. per ac. in dirty water situations. SCVC uses these products to larvicide on Fishers Island.

VectoLex-CG is the trade name for a granular formulation of Bs (strain 2362). The product is formulated on a 10/14 mesh size ground corncob carrier. The VectoLex-CG label carries the "CAUTION" hazard classification. Bs is designed to be applied by ground (by hand or truck-mounted blower) or aerially at rates of five to 10 lbs. per ac. Use of the highest rate is recommended for dense larval populations. VectoLex WSP, a water-soluble pouch, is registered for use in catch basins, and is a recommended product for them. They are also used in fresh water habitats that hold their water, because the cycling of the bacteria provides additional control over time. Bs is not suitable for habitats that dry down, as the bacteria will perish.

Altosid is the name of the methoprene product used in mosquito control and is applied as briquets (similar in form to charcoal briquets), pellets, sand granules, and liquids. The Altosid label carries the "CAUTION" hazard classification. The liquid and pelletized formulations can be applied by helicopter and fixed-wing aircraft.

Altosid Liquid Larvicide (A.L.L.) and A.L.L. Concentrate**:** These two flowable formulations have identical components except for the difference in the concentration of active ingredients. A.L.L. contains five percent (wt./wt.) s-methoprene while A.L.L. Concentrate contains 20 percent (wt./wt.) s-methoprene. The balance consists of inert ingredients that encapsulate the s-methoprene, causing its slow release and retarding its ultraviolet light degradation. Use rates are three to four oz. of A.L.L. five percent and 0.75 to one ounce of A.L.L. Concentrate (both equivalent to 0.01008 to 0.01344 lb. AI) per ac., mixed in water as a carrier and dispensed by spraying with conventional ground and aerial equipment. A.L.L. Concentrate is recommended for aerial and truck applications.

The Altosid Briquet was the first solid methoprene product marketed for mosquito control beginning in 1978. It is made of plaster (calcium sulfate), 3.85 percent (wt./wt.) r-methoprene, 3.85 percent s-methoprene (0.000458 lb. AI/briquet) and charcoal to retard ultraviolet light degradation. Altosid Briquets release methoprene for about 30 days under normal weather conditions. Application should be made at the beginning of the mosquito season and under normal weather conditions repeat treatments should be carried out at 30-day intervals. The recommended application rate is one briquet per 100 square feet in non-flowing or low-flowing water up to two feet deep. Recommended treatment sites include storm drains, catch basins, roadside ditches, ornamental ponds and fountains, abandoned swimming pools, construction sites, and other artificial depressions. Altosid also comes as a XR Briquet**,** made of hard dental plaster (calcium sulfate), 1.8 percent (wt./wt.) s-methoprene (0.00145 lb. AI/briquet) and charcoal to retard ultraviolet light degradation. Despite containing only three times the AI as the "30-day briquet," the comparatively harder plaster and larger size of the XR Briquet change the erosion rate allowing sustained s-methoprene release up to 150 days in normal weather. New Jersey has determined that the risk of resistance from these long-release briquets exceeds benefits that might be gained from their use. They are not recommended for use in Suffolk

County, even if this requires more effort to ensure catch basins and other such structures are treated all season.

Altosid Pellets were approved for use in April of 1990. They contain four percent (wt./wt.) s-methoprene (0.04 lb. AI/lb.), dental plaster (calcium sulfate), and charcoal. As with the briquets discussed above, Altosid Pellets® are designed to slowly release s-methoprene as they erode. Under normal weather conditions, control can be achieved for up to 30 days. Label application rates range from 2.5 lbs. to 10.0 lbs. per ac. (0.1 to 0.4 lb. AI/ac.), depending on the target species and/or habitat. This formulation is effective in penetrating habitats with overhanging vegetation. It is also suitable for wetting-drying habitats, as not all of the product dissolves at once, and so it can provide residual impacts when the habitat wet again.

Storm water structures should receive either Vectolex WSP pouches or Altosid briquets as a preferred treatment. If the recharge basin being treated appears to have clear water, treatment with Bti donuts is possible, and may indeed be preferred due to the general difficulty of inducing resistance with Bti.

Field crews will have equipment allowing treatment of any site with either Bti, Bs, or methoprene. Treatment will depend on the combination of the stage(s) of the larvae, and environmental conditions. Vectolex may be preferred in swampy situations, as it has greater penetration through undergrowth due to the weight of the pellets. The crew leader is responsible for carefully estimating the area of the application (based on dimensions of the application, so that 100 feet by 100 feet is one-quarter of an acre, for example), and determining the amount of product to be used. In-house and NYSDEC pesticide applicator training enable these calculations to be made in a manner consistent with the law and the appropriate label.

Aerial application decisions will be made based on surveillance data. As stated earlier, Bti is often used for early season applications, and methoprene is often the choice for middle of the summer. Applications should be made at very low altitudes to minimize drift.

Table 13. Larvicide Decision Table

| Surveillance Means | Result Class | Quantitative? | Resultant Action |
|---|---|---|---|
| Aerially-larvicided salt marsh | Presence<br>Area Present<br>Stage | @ Wertheim NWR<br>Potentially expandable | Stages I- II: Bti<br>Older: methoprene |
| Other salt marshes | Presence<br>Stage | No | Stages I- II: Bti<br>Older: methoprene |
| Permanent Fresh Water Habitat | Presence<br>Stage<br>Environmental Considerations | Possible | Stages I- III: Bs<br>Older: methoprene |
| Transient Fresh Water Habitat | Presence<br>Stage<br>Environmental Considerations | No | Stages I- III: Bti<br>Older: methoprene |
| Catch Basins | Presence | No | methoprene time release |
| Recharge Basins | Presence<br>Environmental Considerations | No | Stock fish<br>Transient: Bti donuts<br>Permanent: Bs<br>Methoprene time release |
| Artificial (e.g., swimming pools) | Presence | No | Empty<br>If not possible: Bti, methoprene |

### 6.7 Efficacy Measurements

As part of the reorganization of SCVC, a "QA-QC" team should be developed. The intent of this team is to measure the effectiveness of actions taken by SCVC to control mosquitoes. It is clear that the use of pesticides by SCVC is one of the more important elements of the measure of effectiveness of the program. Therefore, a major effort should include the testing of the effectiveness of larvicide applications.

The three major larvicide efforts could be included:

- Catch basins
- Non-aerial larvicide applications (routine monitoring responses, and complaint follow-up)
- Aerial applications

The QA/QC team will have access to application data so that testing is appropriate to the treatment.

Catch basin work is not time sensitive. An appropriate scale of work might be follow-up at a rate of 20 basins per month (tentatively, five basins in four general treatment areas) to dip for larvae to ensure:

1) Untreated basins are not now breeding mosquitoes

2) Treated basins are not now breeding mosquitoes

The intent of the work is to guide the future actions of the field crew to enhance efficiency and ensure that effective treatment is occurring.

Non-aerial larvicide application testing is time sensitive. These sites will need to be visited within a day or two of treatment to sample in a fashion appropriate to treatment. If Bti or Bs were applied, then dipping for larvae is the appropriate measure of success. Bti should kill larvae within 24 hours and so finding live larvae signals that the treatment was not completely successful. For Bs, the finding of stage I and II larvae does not indicate that this slow acting material is not working. Only the presence of stages III, IV and/or pupae indicate that a Bs treatment is no longer working. This test will need to be a relative measure, however, as it is not clear that quantitative determinations of larval density can be based on dip sampling. Discussion with field crews if live larvae are found to determine pre-treatment relative larval densities may assist in deciding if the treatment was successful or not. If methoprene was applied, or a duplex treatment was made, larvae or pupae should be sought for "fly-up" testing. The organisms can be brought back to the laboratory, and their development history traced. Failure to develop is a signal that the pesticide application was successful, although transfer to the laboratory sometimes results in failure to thrive.

In either situation, the measurements will be more effective if similar, untreated wetlands are sampled concurrently to act as control sites. Again, because of the nature of the sampling methodology, it is unclear if the results can always be quantitatively compared.

A similar procedure should be followed to assay the effectiveness of aerial larviciding.

It needs to be understood that tidal flushing in salt marshes, and access issues in fresh water wetlands, will complicate these efforts. The best site selection would be to use a random

selection process, but this must be tempered by practical considerations, to avoid unnecessary travel over a large County to merely satisfy random selection criteria. It should be understood that a geographically appropriate selection of sites would be best, made over the course of the season, and that a good selection of the kinds of treatments made by staff would also be appropriate.

The frequency of testing would be biased towards non-aerial applications, as numerically they represent the majority to applications made by SCVC. Optimal frequencies may be best determined once the program is established; as a coarse estimate, something in the vicinity of 20 sites for truck applications of larvicides, and two aerially larvicided marshes tested each month through the season, seems to be a minimal effort required to develop efficacy information.

The existing New Jersey trap network comprises a programmatic measurement of the effectiveness of source reduction and larviciding. That is, they not only measure whether larvicidal treatments are working, they measure whether enough sites are being treated to achieve an effective result. From a programmatic perspective, it is not enough that for larval control methods to be effective, they must also be used in enough mosquito sources to provide area-wide control. This is especially true for salt marsh species, where only a few uncontrolled acres can infest hundreds of acres after a major hatch. Measurements of adult mosquito population changes at set sites, over longer periods of time so that immediate climatological impacts or individual year's variations are not a factor, will clearly show if the program has been able to reduce the generation of biting adults. The ABDL has conducted such a study, using seven years data prior to the introduction of methoprene, and seven years after its introduction. It is clear from the trends that methoprene resulted in almost an order of magnitude reduction in overall adult mosquito counts, at nearly all of the salt marsh sited traps.

New Jersey trap data are relatively blunt instruments, however. The traps tend to collect mosquitoes from an area and it may not possible to link specific marshes to specific trap counts. Similarly, reductions in larval survival at one marsh may be balanced by increased breeding at a second, uncontrolled site, which means the data will not reflect the effectiveness of treatment at the first marsh.

The use of a specialized QA/QC team in the program would mean that measurements of efficacy will not be compromised by resource competition. It is very important that SCVC be able to provide information to the public that justifies the actions it has undertaken, and that this information clearly identifies treatments that were effective – and those that may not have been as effective.

# 7.0 Control of Adult Mosquitoes

## 7.1 Background Information

Treatment of adult mosquitoes is the control practice most linked by the public to vector control agency operations, although it actually is the last option in terms of effective control possibilities. Most often, this treatment is with pesticides, known as adulticides because they kill adult mosquitoes. Adulticides can be applied either by ground or by air, most commonly via ultra low volume (ULV) or thermal fogging techniques.

Control of adult mosquitoes is generally viewed as the last line of defense against these vectors. It may be the least efficient, as well, because adult mosquitoes are generally dispersed, and are associated with a medium, air, where control chemicals are difficult to concentrate so as to achieve the greatest effect. The term "adulticiding" is used to describe applying insecticide to eliminate adult mosquitoes, either while the insects are flying or resting in vegetation, in/on buildings, or in other sites of harborage. These applications can be made from the ground, via truck-mounted machines, or the air, via airplanes or helicopters, and are mostly applied using ULV equipment. ULV is the application of small amounts of highly concentrated insecticide. The actual amount of insecticide applied is typically in the range of 0.00117 to 0.076 pounds of active ingredient per acre, depending on the insecticide used. This very low application rate is intended to minimize human health and non-target impacts, because low concentrations are effective at killing mosquitoes (the effective concentrations are much less than those used against most hardier agricultural pests, for example). The insecticide is applied using application equipment that produces small droplets that remain airborne and are designed to contact flying mosquitoes. For ULV applications the droplet size produced is generally in the 10 to 50 micron size range, depending on the chemical used and the specific label application recommendations.

Older mosquito spraying technology depended on "thermal fogging," which aerosolized a petroleum/insecticide mix, creating a thick white fog. Thermal fogging is still considered useful under certain conditions, especially when penetration of relatively enclosed places is required. It is considered essential for the treatment of tire piles, for example. ULV is generally preferred, because such treatments use less insecticide per acre, resulting in smaller environmental exposures, savings in insecticide costs, reduction in diluents, and reduced time in loading and

transporting pesticides. Another advantage of ULV spraying is avoidance of dense fogs, which are produced by thermal fogging.

There has been considerable evolution in pesticides used for adulticiding. At one time, DDT and other chlorinated hydrocarbons were used. Then, for decades, organophosphates were used almost exclusively. Currently, most mosquito control agencies, including Suffolk County, rely on synthetic pyrethroids which are chemically similar to naturally occurring pyrethrins. Pyrethroids, in general, do not have large impacts on the environment and are reported to have extremely low mammalian toxicity. However, the widespread use of pyrethroids should not be construed to mean that organophosphates, such as malathion, are not useful. Malathion can be very important if pyrethroid resistance develops in the local mosquito population, for example.

Adulticides used in the US include the organophosphates malathion, fenthion, naled, and chlorpyrifos, and the pyrethrins and pyrethroids. Natural pyrethrins (pyrethrum) are extracted from chrysanthemum flower heads. Pyrethroids are synthetic analogues of the natural pyrethrins, and include resmethrim, sumithrin, and permethrin.

Technical factors that need to be managed for adulticide applications include identifying the target mosquito species, setting the droplet size and dosage rate, and understanding the environmental conditions that will affect the delivery of the pesticide. Delivery systems must be calibrated and managed so as to apply the right dosage to achieve maximal mosquito control and minimal unintended impacts. Suffolk County has recently purchased a model through the resources of the Long-term Plan development project to help insure optimal application of the selected pesticides.

The decision to apply adulticides must be based on information drawn from scientifically-based surveillance activities. Having stated that, the decision will not be based on a single treatment threshold. Applying an adulticide to control mosquitoes is a decision based on the mosquito species, the numbers of mosquitoes present, the threat or presence of a human pathogen, the age and history of the mosquito population of concern, and the time of year. In addition, historical and current trends in the mosquito populations, the current weather, the predicted weather, both short-range and over an extended period of time (seasonality), the environmental setting, and the people in the area where the pesticide will be applied also need to be factored into this equation

(see Table 14). These various factors form a risk determination by program managers, where potential benefits (and potential costs) of applying the pesticide are weighed against the probable costs (and potential benefits) of not applying the pesticide. The costs of not applying the pesticide are the only element described as probable, because at the time of application the present impacts of the mosquito population to human health and public welfare, is the most well-known factor under consideration. In addition to this complex set of variables, there is also, to a certain degree, the expressed preference of the community that may or may not receive the treatment.

Table 14. Adulticide Decision Parameters

| Type of Parameter | | Factor for Vector Control Applications? | Factor for Applications under Health Emergency? | Criteria | Comment |
|---|---|---|---|---|---|
| Basic Surveillance Parameters | Number of mosquitoes | Yes | No | Counts in light traps significantly above norm; landing rates; complaints | Not a fixed value; somewhat species specific; ~ 25 per NJ trap, ~ 100 per CDC trap; landing rate 5+/min.; complaints invaluable where traps are not set; intend to set CDC traps before all non-Fire Island applications |
| | Species present | Yes | Yes | Light trap content analysis | Information on basic mosquito biology essential: Vector Control targets aggressive biters; Health Emergency targets specific (bridge) vectors; ; intend to set CDC traps before all non-Fire Island applications |
| | Complaints | Yes | Yes | Number/location of calls | Evaluate in historic context; complaints must be supported with appropriate surveillance data; complaints document extent of problem better than traps can |
| | Historical population trends | Yes | No | Surveillance data records | Data patterns often signal that problem is about to abate, or is likely to worsen |
| Species Specific Parameters | Aggressiveness of target species | Yes | Yes | Documented biting patterns of trapped mosquitoes | Aggressive biters indicate greater problem, increased likelihood for bridge vector participation |
| | Activity patterns of target species | Yes | Yes | Documented host seeking patterns, flight ranges of trapped mosquitoes | Guides actual control decision; e.g., evening vs. later at night; day-time flying may inhibit control; spot treatments only effective for short flight range species; large flight ranges require applications to cover larger, continuous areas to be effective |
| | Vector Potential | No | Yes | Infection rate, vector competence, % mammalian meals of trapped species | Establishes relative risk for species present |
| | CDC Vector Index | No | Maybe | MIR, trap counts for all potential vectors | CDC light trap counts * MIR, summed over all vector species; higher index correlates to more human infections following week; requires high mosquito/human infection rates for use; can use only with multiple trap data sets |

| Type of Parameter | | Factor for Vector Control Applications? | Factor for Applications under Health Emergency? | Criteria | Comment |
|---|---|---|---|---|---|
| Species specific parameters, continued | Parity rates | Sometimes | Yes | Age (blood meal history) of biting population | For Health Emergency, high parity rates indicate majority of biters had prior blood meal – direct indication of increased Vector Potential; for Vector Control, an aging population, even if smaller, will be treated since it represents increasing vector potential |
| | Life Cycle Type | Yes | Yes | Trap analysis | Brooded mosquitoes eventually die off on own, continuous breeders build populations over season |
| Public Health Parameters | Bird testing | No | Yes | Presence/absence of virus | Provides early warning in terms of bird to bird transmission; documents active disease foci in County |
| | CDC mosquito pool testing | No | Yes | Presence/absence of virus | Amplification vectors provide early warning, document active disease foci in County; bridge vectors indicate virus present in human biting species, is signal that human health risk is imminent |
| | Veterinarian reports | No | Yes | Ill/dead target animals | Non-mammals provide early warning, document active disease foci in County; mammalian cases indicate virus present in bridge vectors, signal that human health risk is imminent |
| | Physician reports | No | Yes | Human cases | Realized human health threat |
| | Disease history | No | Yes | Number of human/ important animal cases in prior years | Indicates that local conditions are favorable for pathogen amplification and transmission |
| | Avian dispersal/migration patterns | No | Yes | Time of year regarding dispersal of hatch year birds and known migration periods | Identifies new areas for concern, signals need to control known bridge vectors |
| Climatic Parameters | Current weather | Yes | Yes | Temp = 65+<br>Wind < 10 mph<br>No rain | Application time decision |
| | Short-term weather forecast | Yes | Yes | Presence of fronts & storms; barometric patterns | Application planning |
| | Time of year | Yes | Yes | Spring, Summer, & Fall activity patterns for trapped mosquitoes | Species-specific behavior; generally, cooler weather retards activity, warmer weather increases activity; virus presence not as significant when activity decreases |

| Type of Parameter | | Factor for Vector Control Applications? | Factor for Applications under Health Emergency? | Criteria | Comment |
|---|---|---|---|---|---|
| Ecological Parameters | Environmental factors in target area | Yes | No | Environmentally sensitive settings (R-T-E species) | Prior mapping is essential to clearly identify all environmentally sensitive areas; usually addressed through NYSDEC; Town and other expert cooperation is sought |
| | Population | Yes | Maybe | Number of impacted people/population density | For Vector Control: no people means no problem; for Health Emergency, threat may be sufficient |
| | Application restrictions | Yes | In some settings | Farms; no-spray list; NYSDEC wetlands, wetlands buffers; open water buffers; FINS | Vector Control no-spray areas include crop areas, no-spray list, buffers – discontinuities may make application ineffective; FINS Health Emergency criteria are more stringent than County criteria |

The control of adult mosquitoes means managing their populations so that they cause less of an impact to people. Suffolk County has a pesticide phase out law that sets a goal of limiting or eliminating pesticide use when possible. Mosquito adulticides must be used in residential areas to control mosquitoes that are biting people. This means that human exposure to the materials is inevitable, and efforts to minimize exposure to pesticides are prudent. In addition, it is at least theoretically possible that there are as yet unknown adverse impacts that could result from use of these materials, so that it is wise to place limits on their use.

This interest in reducing or eliminating pesticide use is expressed in the evaluations of alternatives to pesticides. This section will begin by discussing some of the most commonly discussed alternatives to adulticides, and evaluate their potential for ensuring protection of human health and the alleviation of discomfort that often accompanies large or dangerous populations of adult mosquitoes.

## 7.2 Alternatives to Adulticides

There are four general alternatives to adulticides:

- Use of personal protection/avoidance of mosquito conditions
- Barrier treatments
- Enhanced predation
- Traps

*Personal protection steps*

Mosquitoes may be avoided. Steps can be taken, including the installation of screens; in some areas, mosquito nets (especially those impregnated with pesticides) are commonly used. Widespread use of air conditioning tremendously reduces contact with mosquitoes, as some mosquitoes can negotiate screens. This can mean isolating oneself from the portion of the world the mosquito inhabits, and avoiding outside activities during the part of the year that for many is when outside activities are most common (i.e., summer).

It is possible to find effective means of repelling mosquito bites. The compound DEET (N,N-diethyl-m-toluamide) was first registered as an insect repellent in 1957. It is used to repel biting insects, such as mosquitoes, ticks and flies. It is believed that DEET repels insects by interfering with the insect's ability to sense or locate animals to feed on. DEET can be used in homes, applied directly on the skin and clothing, and can be used to protect animals, such as dogs, cats and horses. The percentage of DEET in products can vary, ranging from about 5 to 100 percent. It is remarkably effective. Studies of DEET have shown consistent abilities to allow people to share space with mosquitoes seeking blood meals and yet avoid nearly all bites.

Up to 20 percent of a dermal application of DEET can be absorbed through the skin. It is generally eliminated through urine within several hours, and does not accumulate. Use of sunscreens with added DEET may enhance absorption.

There have been some reports of seizures in children using DEET products. The number of cases of effects appears to be quite small, given broad estimates of 50 to 100 million users each year. USEPA concluded that although DEET was implicated in certain seizure cases, evidence of it causing them was insufficient. Nonetheless, USEPA suggested it is prudent to exercise caution in the use of DEET directly on the skin. There are some indications that long-term use may have some negative effects, although these reports are either from animal studies or are anecdotal. Studies of synergistic effects of DEET with other chemicals (from Gulf War Syndrome research) are not conclusive (see the discussion of permethrin, below, for more details).

The US Army has found it difficult to ensure that soldiers use DEET as ordered. Compliance rates, even when under orders, are as low as 50 percent. Aesthetic problems, including the feel of the repellent on the skin and its odor, are cited (as well as fears associated with some of the concerns raised above). The Army is now developing its own alternative to DEET.

Some repellents are said to be "just as good" as DEET. Most do not measure up in independent research. Some that have fared well include:

- BiteBlocker (a botanical product)

- Picaridin (a European product) recently received approval as effective by the CDC and registered in New York State

- Oil of eucalyptus (a botanical product) recently received approval by CDC as an effective repellent

Citronella based products has not measured up, despite word of mouth to the contrary. It may be that reactions between an individual's skin/skin chemicals/other applied soaps, perfumes, etc., result in particular combinations that serve to repel mosquitoes. This may account for products that have fierce loyalties, but test poorly. However, for citronella, Health Canada has raised concerns regarding potential negative impacts to people from use of the material on the skin.

All-in-all, it is clearly possible for individuals to construct effective means of fending off mosquitoes through personal actions. However, there may be some negative health or social impacts associated with mosquito avoidance. Also, note that NYSDOH guidance, when facing large numbers of biting mosquitoes, is to use DEET on exposed skin, with permethrin-impregnated clothing as an additional repellent measure (thereby increasing the individual's exposure to pesticides). Nonetheless, if significant portions of the population were persuaded to stay indoors more, and to use effective repellents when outdoors, the need to adulticide would be less. However, if a significant proportion of the population did not comply, public health officials would still determine that the risk equation favored the use of adulticides to avoid human illness.

*Barrier treatments*

These products primarily function as area versions of the human repellents listed above. The idea is that mosquitoes will avoid the area where they have been applied. Mostly, they are considered minimum risk compounds by USEPA and therefore do not require federal registration under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Further, in most states, these products are not classified for regulatory purposes as pesticides, so posting, notification, and reporting laws do not apply.

Most efficacy information is not from published articles in scientific or professional journals, but rather sponsored reports or testimonials. Products typical of the class include:

- EcoSmart Technologies Corporation developed EcoExempt IC, an insecticide concentrate containing a blend of plant oils, labeled for outdoor yard and barrier treatment for mosquitoes. The only available data on this product comes from company sponsored tests, reporting immediate knock-down of flying mosquitoes in laboratory settings. No non-target impacts or field studies are available. The chemicals in the product can sometimes damage its application equipment.

- Garlic and garlic oils have been touted as mosquito repellents, and, sometimes, pesticides. Two well-known garlic-based adult mosquito repellents the Mosquito Barrier (or the Garlic Barrier), and Mosquito and Gnat Scat. Mosquito Barrier reportedly kills adult mosquitoes and repels them from treated areas, and, when mixed with canola oil, will kill mosquito larvae. SCVC has performed local tests on garlic oils as barrier treatments informally, and they were tested as part of the Long-Term Plan Early Action Projects. The tests showed that garlic oils could reduce the number of mosquitoes reaching mosquito traps in treated areas by up to 50 percent, as compared to non-treatment areas.

Mosquito Scat is an herbal oil preparation containing three oils as active ingredients: lemon grass oil, peppermint oil, and garlic oil. It is sprinkled outside to repel mosquitoes. One university study found no significant differences in mosquito numbers in the comparison of treated versus untreated areas.

Generally, unlike the local results found as part of the Long-Term Plan, garlic repellents do not appear to have worked well at discouraging mosquitoes, especially when densities were higher. It might be argued that a 50 percent reduction in numbers when mosquito counts are high is not sufficient to eliminate a "problem." For instance, New Jersey light trap data used by SCVC generally finds background, i.e., "non-problem," quantities of aggressive mosquitoes to be in the vicinity of five per night. By most definitions, a count of 25 aggressive mosquitoes per night constitutes a biting problem. Reducing that count by 50 percent reduces the impact, but does not return conditions to background levels.

- Hand-held electronic devices relying on high-frequency sound to repel mosquitoes continue to come to the marketplace. They often claim to work by mimicking the wing beat frequency of a male mosquito or even the wing beat frequency of a hungry dragonfly.

Scientific studies have repeatedly shown that electronic mosquito repellers do not prevent host-seeking mosquitoes from biting.

- The Mosquito Cognito emits a chemical that, according to the manufacturer, has a unique scent-blocking ability, because it binds to mosquito olfactory receptors and blocks the mosquito's ability to smell people and animals. The Mosquito Cognito looks something like a square suitcase or ice chest, and can be placed outside on decks or porches where people are gathered. A university report found

  > While it can keep distant mosquitoes from locating people, it cannot prevent nearby mosquitoes from locating people by vision or by the person's thermal emissions. For this reason, it is inappropriate for use within mosquito habitat.

- Mosquito Barrier, a citronella and rosemary solution, was applied by the Long-Term Plan to several sites. This product was touted as an effective mosquito repellent and is similar to Mosquito Scat, albeit with no garlic in it. The product did not prevent mosquitoes from reaching mosquito traps in the middle of treated areas at the same rate they reached traps where no treatments were made.

None of these products has demonstrated the level of efficacy offered by pesticides, which generally are found to reduce mosquito counts by 90 percent. In addition, these products tend to be limited in the aerial coverage they offer, and may merely deflect mosquitoes to another site. This means that, as a relatively rare use, any one of the products could be effective and provide some degree of comfort for those people in a specific area affected by the product. However, it is far from clear that the products would maintain effectiveness if widely used, as mosquitoes might have no alternative areas to forage in, and so overcome the barrier tendencies.

Another approach is to try to treat for mosquitoes over a particular, defined area. Most of these space repellants are used to protect individuals inside the home or in the yard. They are most effective indoors. Outdoors, the insecticide particles disperse rapidly and, therefore, may not be effective. Many household aerosols contain synergized pyrethrum or a synthetic, pyrethroid equivalent such as allethrin, or resmethrin. This makes these products equivalent to pesticides used by SCVC, albeit without the application controls, and with the risks associated with

pesticides assumed voluntarily (assuming there are no impacts outside of the immediate vicinity of the application).

Another common repellent choice is oil of citronella candles, torches, or coils. These can be used outdoors, but only in situations where there is minimal wind. One experiment found that ordinary candles had approximately the same repellent impact that citronella candles had (a reduction in bites of between one-quarter and one-half).

*Enhanced predation*

Predators touted for effectiveness against adult mosquitoes include dragonflies, birds (especially purple martins), and bats. These have been discussed above in Section 4, under "Biocontrols." Generally, except for dragonflies in a few select environments, enhanced predation appears to be ineffective as a means of controlling adult mosquitoes.

*Traps*

Special traps have been developed in the last few years that attract and catch large numbers of mosquitoes, thus potentially removing them from a radius around the trap. Brand names of such traps include the Mosquito Magnet, Mosquito Megacatch, the Flowtron Power Trap, the Dragonfly, the Lentek Mosquito Trap, The Lentek Eco Trap, Mosquito Deleto, and the SonicWeb. This technology is developing rapidly and there is considerable variability in the way these traps function. The vast majority of these traps use $CO_2$, produced either through the combustion of propane or via a $CO_2$ cylinder, and released at between 350 ml and 500 ml/min. The plume of $CO_2$ discharged mimics human exhalation and makes these traps specific for capturing blood-feeding insects. The $CO_2$ is often synergized with 1-Octen-3-ol, a derivative of gasses produced in the rumen of cows, to increase attractiveness by several orders of magnitude. The 1-Octen-3-ol is slow-released at a rate of approximately 0.5 mg/h. The traps also vary in the manner in which mosquitoes are trapped/killed. Some traps have a fan to suck insects into a collection chamber or bag, while others contain a glue board to catch the insects. Several of these traps claim to protect as much as an acre of land. Generally, however, mosquito control professionals are becoming convinced that trapping mosquitoes is not efficient enough to control mosquito populations sufficiently to prevent biting complaints. This is especially true when

mosquito populations are dense and aggressive biters. The traps are gaining notice for their ability to capture good samples of the human-seeking mosquito population and so they may become standard surveillance equipment. For one, they capture day-flying mosquitoes when operated all day, and, unlike CDC and New Jersey traps, contain no lights to capture "trash" insects as well as the desired mosquitoes.

Arranging the traps so that they enclose spaces that warrant protection seems to be more effective than setting out an individual trap to protect the surrounding area. The Long-Term Plan tested this concept experimentally. The results showed that CDC light traps within areas protected by mosquito traps actually caught more human biting mosquitoes than did a CDC light trap located away from the array. This provides credibility to the scoffers who have said that the traps actually serve as attractants of mosquitoes, and do not reduce mosquitoes in the areas they are established.

### 7.3 Treatment Decisions

It must be emphasized that when adulticiding is being considered, it is in the context of IPM. Mosquito control has been undertaken through public education, source reduction (including aggressive, progressive water management programs), and larviciding. Adulticiding is being considered as the last means of achieving protection of human health and public welfare. It is certainly not the management tool of first choice for Suffolk County.

There are two possible conditions for adulticiding to occur under. One is when a health emergency is declared, and the other is for vector control purposes. In either case, a multivariate assessment of scientific surveillance information will drive the decision-making.

Typically, adulticide treatments are differentiated between those that are undertaken for the protection of human health and those that are needed for public health nuisance abatement to provide for relief of human discomfort. The planners of the County mosquito program have found it difficult to clearly separate these two kinds of event. For one, mosquitoes that are controlled and which carry the greatest risk of disease transmission tend to be very aggressive human biters. This means that reducing their numbers to reduce disease threats also reduces the level of discomfort experienced by people. Secondly, the conditions that cause the most

discomfort to people in Suffolk County (large numbers of *Oc. sollicitans* mosquitoes in coastal communities) also contain a certain amount of disease risk. This is because *Oc. sollicitans* is the vector of greatest concern for EEE, and with any disease vector, the best protection from disease (if efforts to eliminate larvae have not succeeded) is to keep the population young. This is because newly emerged bridge vector mosquitoes cannot infect humans (given the disease prevalence in the County). Only older mosquitoes, which have fed previously (parous mosquitoes) and have become infected, can pass along the disease. Preventing or severely reducing the number of parous mosquitoes means that opportunities for disease transmission are limited.

In addition, prevention of human bites also improves general public health, due to the non-clinical impacts of mosquito bites such as rashes and allergic reactions. Elimination of aggressive biting mosquitoes also clearly improves public welfare for those in the afflicted areas. *Oc. sollicitans* often rests in grassy areas during daylight hours, and, if disturbed, it will opportunistically feed. This means control of these adult mosquitoes, when populations have reached peaks, makes the use of yards by children and residents possible, and even allows for such routine activities as mowing the lawn. Without control, these kinds of activities might be severely disrupted by biting mosquitoes. Even those who work during the day benefit, as walking to the car in the early morning or evening can result in multiple bites in less than a minute when a brood has reached the area.

"Vector control," a term often used with some derision by those who oppose any chemical control regardless of the degree of infestation, is a major element of protecting the public health, welfare, and quality of life. Instead of being discrete kinds of events, adult mosquito control actually describes a continuum of control rationale, where neither a purely health protection event nor a purely nuisance control event can be considered likely to occur.

It is an axiom of many of the adulticide events that will occur under this Long-Term Plan that the alleviation of severe human discomfort has public benefits. Justifications for understanding the public benefits of such a stand include the personal benefits received by many in the target area, and also the perceived economic benefits that may accrue to many across the County. Tourism and related outdoor activities are important economic factors. All residents understand the value

of the waterfront and related industries, that outdoor recreation such as golf and sightseeing are important summertime activities, and probably comprehend that the summer East End-Fire Island resort communities depend on those visiting and renting there being able to go outside when they wish.

This public policy is supported by the determination that there is little to no human health cost to the control of mosquitoes, using modern pesticides, at the rates currently planned for across the County. The model of potential environmental impacts shows there can be some effects from the use of these chemicals, especially to some aquatic organisms and to night-flying insects. Nonetheless, use of them is to be pursued due to four mitigating factors. One is that the model quite probably overestimates environmental exposure to the agents, as locally collected information is making it clear that many of these compounds degrade more quickly than was ever anticipated. Secondly, the "bee" model for flying insect impacts, which relies on understanding impacts to bees, is probably not appropriate for considering impacts under these conditions. Bees do not fly at night, and these adulticides do not have residual effects. Bees are very sensitive to pesticides, more sensitive than most large flying insects; it is generally found that ULV mosquito applications tend not to reach toxic levels for most flying insects, as finer droplets do not deliver fatal doses. Secondly, the impact is limited in duration, as the community modeling suggested that aquatic species recover over the winter when no pesticides are applied, and some limited sampling in California found near immediate recovery for airborne insects. Thirdly, the amount of the County impacted by these chemicals is limited. The acreage of adulticiding for 2003 (a year when more pesticide than average was applied) was 34,880 acres compared to a total area of the County of 655,632 acres, meaning adulticiding in a high application year affected approximately five percent of the land area of the County. Another means of quantifying the limited exposure to the adulticides is that the "coastline" (counting streams and rivers) affected by adulticide use in 2003 was 220 miles of 1,852 miles County-wide, which constitutes approximately 12 percent of the coast (please note that these fractal kinds of measurements of coastlines vary considerably depending on scaling and other issues, and so should be understood to be very approximate measures). Many of these applications, because they occurred by truck or hand-held methods, had limited means for impacting aquatic environments due to intentional setbacks and also natural barriers that exist between the point of application (generally, a road) and the waterways.

Under a declared health emergency, the benefits associated with pesticide use include disruption of transmission of disease. The adulticide treatments are not made wherever indications of disease are found, but rather where the risk factors indicate that the greatest possible risk is located.

Control decisions are not made merely on the number of mosquitoes, or the amount of human biting that is occurring. These are important issues, but they are not definitive. Other information is required in order to determine if adult control is necessary:

- Species of mosquitoes present, from trap data
- Relative numbers of mosquitoes, by species, from trap data
- Population trends, from past data sets and control sites
- Aggressiveness of the mosquito population, inferred from trap data, based on species composition, based on complaint logs, and/or from landing rates
- Activity pattern of the species of concern (preferred feeding habits, resting habitats, etc.), from trap data
- Presence or absence of virus, from laboratory analysis of mosquitoes, dead birds (may no longer be realistic), sentinel birds, and/or wild avian surveillance, or the presence of human cases
- Analysis of the risk posed by the particular virus, based on professional judgment and CDC-NYSDOH guidance
- Parity of mosquitoes
- Bird migration patterns
- Current weather and short-term weather forecasts
- Long-term weather trends (time of year considerations)

Not every decision can have or needs to have a complete information set, and sometimes decisions may be tentatively made and then confirmed based on immediate data collection. The kinds of applications that have historically been made will be revisited in light of the Long-Term Plan decision process, to illustrate how the process should function.

There are several areas in the County, mostly along the south shore, that typically experience inundations by broods of salt marsh mosquitoes several times in a year. It is intended that progressive water management will reduce the number of these incidents. Experience in other jurisdictions indicates that fish predation on larvae is more consistent than the effects of larvicides. Larvicides, if properly applied, should provide a great deal of control. However, sometimes the applications are adversely affected by weather, or tides may wash the pesticides off the marsh.

Knowledge of the mosquito broods comes to SCVC management in several ways:

- Reports from field crews prior to the outbreak, suggesting large numbers of larvae were present on the salt marsh (as a prelude to larviciding)
- Follow-up reports from field crews conducting larval surveillance on the marshes, indicating high numbers of biting adult mosquitoes on the marshes
- Increases in biting complaints from the community (these are logged and mapped by SCVC)
- Requests from elected officials (mayors, legislators and others) or community groups.
- New Jersey light trap data, indicating increases in *Oc. sollicitans* numbers in the sentinel traps

These events can sometimes be foretold, based on tide predictions of higher tides. However, the microtidal nature of the South Shore Estuary means that the highest tides (and therefore greatest marsh inundations), which precede the largest larval hatchings, often result from storms, and not necessarily lunar forces.

All complaints are followed up. Therefore, field crews will be dispatched to the areas where complaints are being logged, and will confirm (or not) that an infestation has occurred (people with party or holiday plans have been known to try to arrange for prophylactic applications to ensure no mosquito disruptions). Informal landing rate tests across open fields are a good test for the presence of *Oc. sollicitans* during the day. If trap counts are excessive (in the neighborhood of 25 biting adults per trap night, compared to a more usual zero to five count, in New Jersey light traps, and approximately 100 mosquitoes per night in a CDC light trap), and mosquitoes have been confirmed, the general area where the infestation is occurring is mapped, based on complaints received and the follow-up visits by field crews. Since truck applications are the typical means of responding, the road network of the area is used to determine the potential boundary of the application. Weather forecasts will be accessed to determine if conditions seem to be acceptable for a potential application, and to ensure a cold front or other storm situation will not occur to eliminate the need for the application. It is also assumed that the time of year indicates that the infestation is not about to become less due to cooler temperatures, as might be the case in September or later in the season, or in May or early June (mosquito activity slows with decreasing temperature, and rises with increasing temperatures). Population trends for the particular area will be observed to ensure that typically these conditions do persist (most of the areas where such control treatments are considered are well-known to SCVC administrative staff). No-spray addresses and key environmentally sensitive areas are factored in, and then the application area is noticed, so that an application can occur the next evening.

At this time, the QA/QC team should locate a suitable area in or near the center of the application block, and set up a baited CDC trap for confirmatory sampling. This trap would also be used for baseline data as a measure of treatment efficacy. Another trap, outside but near to and in a somewhat similar setting, could be established for a control site. In the morning, the two traps would be collected. The species and number of biting mosquitoes would be noted. A target for the decision to continue with application plans would be the presence of 100 or so biting mosquitoes in the CDC trap of interest. Anything substantially less than this, or a notable shift in the speciation of the trapped mosquitoes, requires reassessment of the application decision.

Assuming that the trap confirms the decision, and the weather is appropriate, the application will occur on the second evening. The next night, CDC traps would again be set, and the collected data used to calculate the efficacy of the application. The intent of the control program is to reduce targeted species' numbers by an order of magnitude (measured trap counts, as adjusted by the control results, would be expected to be 90 percent less than the original counts). These actions are intended to reduce impacts to the quality of life experienced in the neighborhood, and also to reduce disease risk by eliminating older mosquitoes from the available population. Breeding may also be slightly curtailed (but unless the marshes are also targeted, not enough of the salt marsh mosquito population will be killed to seriously impact overall breeding). Populations out on the marshes can only be successfully curtailed through effective water management and larvicide applications.

It is possible that areas outside of typical locations impacted by biting mosquito problems will appear to need treatment. In these cases, initiation of recognition of a problem will probably begin with complaint calls, and continue with follow-up on the calls. It is less likely a set New Jersey light trap will be set conveniently to assess the problem, and so the analysis may not proceed quite as quantitatively as described above. It is all the more important to analyze overall mosquito population trends for this season and previous seasons, in these cases, and to set the pre-application CDC light traps, and carefully analyze the data from those traps prior to confirming any application decision.

Figure 3 illustrates the decisions that are made to reach a vector control application decision. The term "professional judgment" is used to show that the decision most often involves weighting the factors that appear to indicate that control is necessary in light of those factors that indicate control is not necessary.

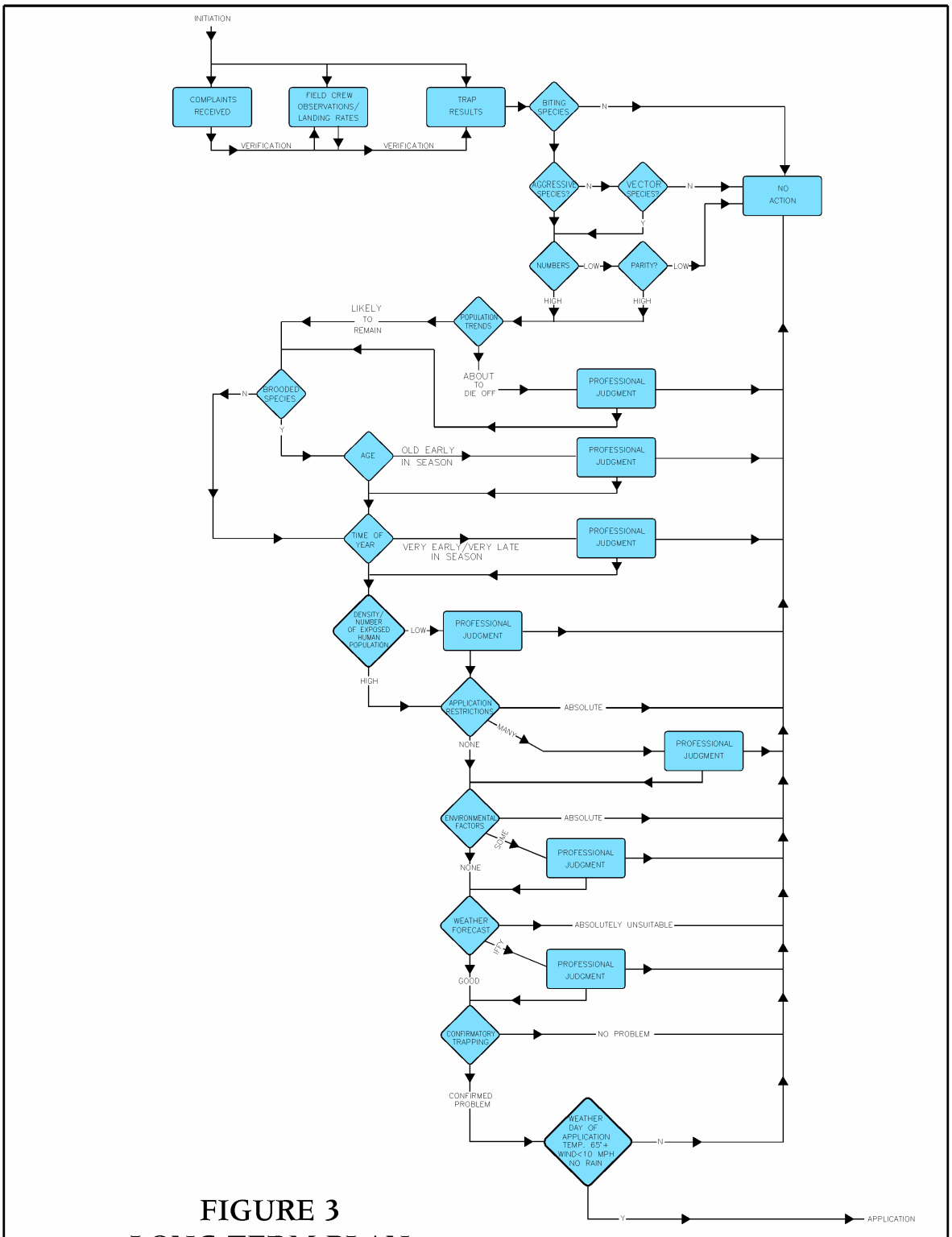



FIGURE 3
-LONG TERM PLAN-
VECTOR CONTROL
DECISION TREE

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*Fire Island Communities*

A subset of this kind of quality of life control measures occurs in the Fire Island communities. There, active, more comprehensive surveillance will be undertaken through the siting of three New Jersey traps. However, the routine pre-application sampling and efficacy measures will not be routinely made here. Partly this is determined by the relative isolation of the communities from the rest of Suffolk County, and partly this is a practical appreciation of the cause of the overall problem.

Several of the Fire Island communities have volunteer or appointed mosquito management boards, with mosquito control coordinators. SCVC maintains contacts with thee coordinators, who are tasked with speaking generally for the community and its interest. These coordinators are the prime source of information concerning biting rates in the communities.

Recent history has been that several of these coordinators tend to report that biting rates are intolerable at about the same time. This is because the salt marsh system along the bayside breeds regularly and productively in the parts of FINS where control is not allowed. It is this policy associated with FINS (and National Parks, in general), which is that natural processes should not be interfered with if at all possible, that is the source of the special problems on Fire Island. The wetlands breed ferociously, and then the mosquitoes, as has been demonstrated by Park biologists using mark and recapture techniques, migrate along the barrier beach in search of blood meals. Most *Oc. sollicitans*, it also has been shown, feed on mammals other than people (such as deer, mice, muskrats, etc.). But there are enough *Oc. sollicitans* in an uncontrolled hatch to ensure every resident has a mosquito (or more) waiting for a meal. Breeding in the Seashore may actually be enhanced by the current FINS marsh reversion policy, as many of the marshes have become isolated by shoreline berms, and so have degraded water quality that precludes fish predation. FINS is researching its marsh conditions to determine if it has a need to actively manage the marshes (not for mosquito control purposes, per se, but to improve overall marsh health).

When the complaints come from the coordinators, SCVC will tentatively establish its schedule for adulticiding in the communities that desire treatment. The need for treatment will be quantified by the New Jersey traps, and through contacts to FINS to receive the trap data from its

traps (all of which are outside of the communities, but should approximate uncontrolled conditions), to establish a quantitative basis for treatment. If treatment is justified, and weather permits, hand-held applications will be initiated in the communities. These will continue on a regular, weekly basis, assuming all conditions within the salt marshes of the Seashore remain constant. This is because the uncontrolled nature of the Seashore salt marshes leads to regular inundations of the communities by salt marsh mosquitoes.

Treatment could, in fact, be justified more than weekly much of the season. The permanent New Jersey traps should demonstrate some efficacy associated with the applications, and also the need for continued treatment. That the treatments are not a complete solution to the problem does not mean that they do not provide a degree of relief to the community over several days, and perhaps for up to a week (weather is a large factor in how long control is maintained). This is one of the reasons that SCVC is entertaining the use of the mosquito trap network as an alternative to pesticide use. In order to avoid unnecessary treatments, field crews on the scene will conduct landing rates to verify that a mosquito problem exists before any treatment, and will cancel if no activity is found.

Figure 4 illustrates the process followed prior to making a decision as to whether to conduct a vector control application on Fire Island or not.

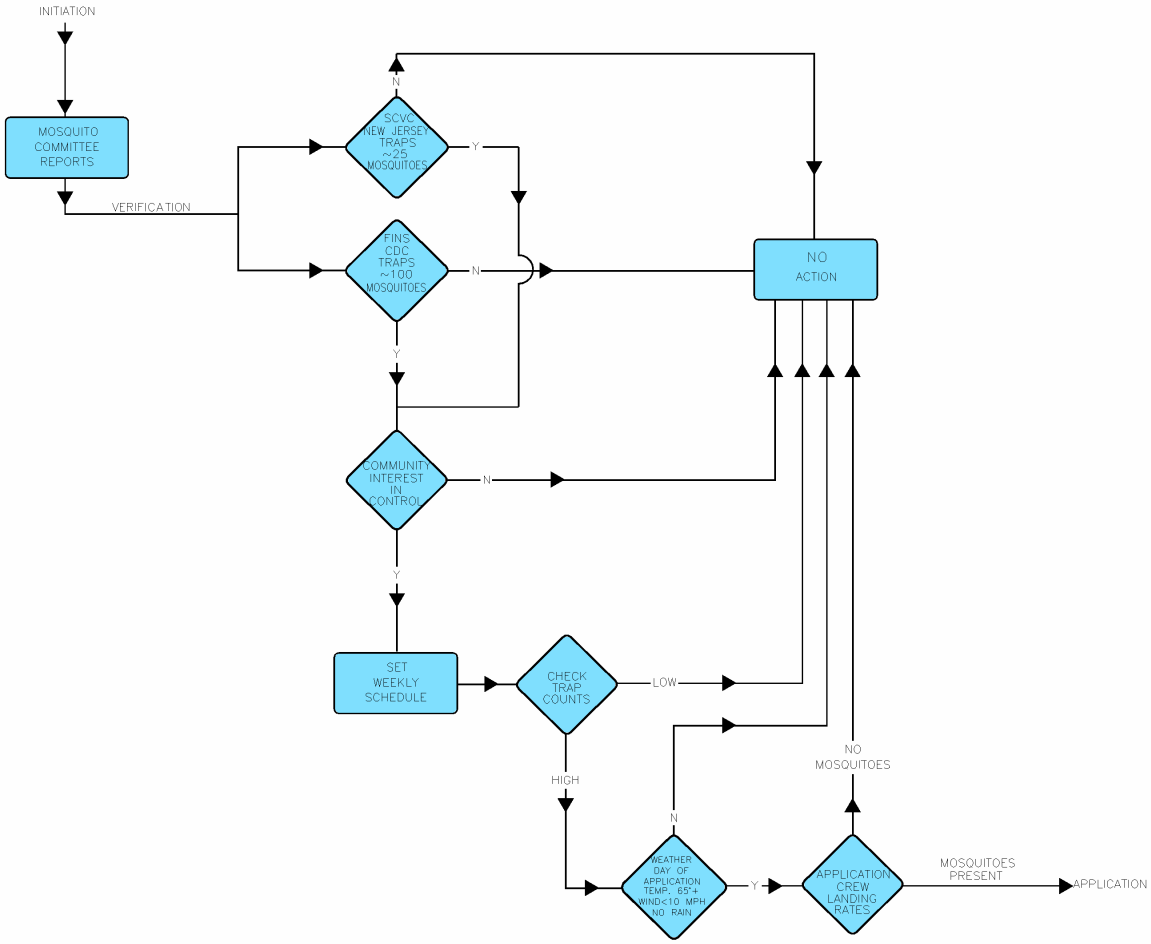


FIGURE 4
-LONG TERM PLAN-
FIRE ISLAND VECTOR CONTROL
DECISION TREE

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*Declared Health Emergencies*

Control decisions under a declared health emergency are different. SCDHS is responsible for ensuring that the risk assessment has been properly conducted, and reviews the operational plan proposed by SCVC to meet the required risk reduction. The risk assessment first requires that mosquito-borne disease has been detected in the County. On rare occasions the problem has been malaria; however, the modern mosquito-borne diseases of concern are arboviruses. The most prominent of these, and the ones most likely to be detected in the County, are WNV and EEE.

The County's disease management protocol is based on the NYSDOH four-tiered WNV response strategy. It differs is some minor respects from that overall approach, but essentially follows the overall strategy. Table 15 summarizes the NYSDOH WNV response strategy.

Table 15. NYSDOH Four-Tiered WNV Strategy

| Tier | Circumstances | Response |
|---|---|---|
| I | No historical or current evidence of virus<br>No neighboring Health Unit with historical/current evidence of virus | Level 1 education campaign<br>Enhanced passive human/bird surveillance<br>Consider adult mosquito surveillance (species, distribution)<br>Lower priority for lab testing<br>Consider larval surveillance<br>Consider local environmental assessments<br>Consider local disease risk assessments |
| II | Historical evidence of virus<br>Neighboring Health Units with historical evidence | Level 1 enhanced education program (general community & provider community)<br>Local environmental assessments<br>Local disease risk assessments<br>Active human (if evidence in-unit)/bird surveillance<br>Larval surveillance<br>Larval habitat source reduction<br>Larval control<br>Adult surveillance and lab testing |
| III | Current virus isolation/evidence of infection in individual locations | Level 2/3 education program (general public & provider community)<br>Active human/bird surveillance<br>Larval surveillance<br>Larval habitat source reduction<br>Larval control<br>Adult surveillance and lab testing<br>Adult control, ground application |
| IV | Current virus isolation/evidence of infection in multiple locations | Level 2/3/4 education program (general public & provider community)<br>Active human/bird surveillance<br>Larval surveillance<br>Larval habitat source reduction<br>Larval control<br>Adult surveillance and lab testing<br>Adult control, ground application |

Because WNV and EEE have been historically detected in Suffolk County, the County essentially begins each mosquito season in Tier II of the NYSDOH tiered approach.

Over the period 2000 to 2004, the signal of WNV presence in birds was finding dead crows that tested positive for virus. It appears that nearly all susceptible crows have died from the disease, and the survivors and their off-spring do not readily perish from WNV, at least as often as they used to. This means that new sentinels must be developed. Possibilities include sentinel chicken flocks (an approach that did not succeed when first tried in the County, but which has been successful elsewhere in the country), netting adult birds, or taking blood samples from nestlings. The latter holds great surveillance potential for early in the season, as the birds are sessile, and

there is no potential of being seropositive from earlier exposure, or exposure elsewhere. A positive result would indicate that virus is circulating in that immediate area. However, nestlings often leave the nest just as WNV becomes of greatest concern (early August), which would mean changing surveillance tools at a key moment. In addition, permit issues make this kind of surveillance very difficult to administer. Nonetheless, the County should seek to develop some new means of conducting sentinel surveillance for WNV. Whatever method is selected, testing of these samples could continue to occur in-house, with some samples sent to NYSDOH in Albany for confirmation and more inclusive general viral scans.

If no alternative bird surveillance tool is developed, the County will need to step up its use of baited CDC traps, collecting more samples, more frequently, and from many more locations. Currently, baited CDC traps are set at fixed stations in areas where EEE and WNV have reoccurred, and more are set to investigate bird deaths and positive bird samples. Gravid traps are also set to particularly target *Cx. pipiens* (for WNV surveillance). Absent bird deaths to target sampling, means of generally conducting surveillance across the entire County will need to be established. This will require some method of increasing the density in both time and space of the CDC trap network. Increasing the number of CDC trap samples collected is very labor intensive, both in terms of managing the traps (set-outs and sample collections) and in processing the collected samples. The nature of mosquito-borne disease is also that a low infection rate in mosquitoes can result in very high infection rates in target species, so that sampling mosquito pools is often less efficient at identifying areas where infectious agents are present and circulating. For these reasons, identification of alternate bird sampling methodologies is preferable.

If surveillance reveals the presence of WNV (birds or mosquito pools), the County will petition to the State Commissioner of Health for a declaration of a Health Threat. This allows the County to apply for reimbursement of certain expenses in SCDHS relating to mosquito control, and places SCVC formally under the direction of the Commissioner of SCDHS. It is also a necessary first step prior to any declaration of a Health Emergency. This also moves the County to Tier III of the NYSDOH tiered response strategy.

A health threat declaration will also be sought in sampling results from *Cs. melanura* pools shows that EEE is amplifying in bird populations. This is signaled by detection of a *Cs. melanura* positive pool from samples sent to Albany for analysis.

The declaration of a health threat will also be accompanied by public education, through SCDHS press releases and web site publications. These are intended to draw attention to the heightened state of concern regarding mosquito-borne disease. Localities where virus has been detected will be called out specifically, but the outreach is intended to remind all Suffolk County citizens and visitors of the steps that can be taken to minimize the chance of being bitten by mosquitoes. In addition, SCDHS will contact its physician and hospital reporting network, and touch base with its local veterinarians. This ensures that any human or sentinel animal cases of mosquito-borne disease are promptly reported.

Detections of clusters of positive WNV pools for *Cx. pipiens* would signal the potential for adulticide control. In that case, the presence or absence of potential bridge vectors would be an important consideration, especially if the bridge vectors tended to have a higher parity rate. For floodwater mosquitoes, a determination as to whether a brood was waning naturally, and need no control for numbers to be of little concern, would also be a factor, although not necessarily a compelling one. With bridge vectors, older mosquitoes are much more dangerous than young mosquitoes, so a large population of virgin mosquitoes is much less risky than a small population entirely populated by blooded mosquitoes. Time of year is important, as it has been suggested that *Cx. pipiens* changes its feeding habits after the first week of August or so, and feeds more regularly on humans. This makes it a more dangerous mosquito, especially as the species (in general) transitions from bird feeding to human feeding (increasing the potential to pass virus along). In late summer, as night temperatures drop, *Oc. sollicitans* begins feeding more commonly during the day. This makes control harder, as the mosquito is less likely to be flying when the insecticide would be applied. Thus, late summer-early fall adulticiding is less common for *Oc. sollicitans* control purposes. These conditions move the County to Tier IV of the NYSDOH tiered strategy.

Another factor considered in control decisions is the size of population (and its composition, if greatly different from the County as a whole) in the near vicinity of the problem. Generally, the

more people potentially exposed to the disease threat, the greater the likelihood of an adulticide application – although if the perceived risk is exceptionally high, then the number of people exposed is not as much a factor (i.e., 100 percent infection rates for five people means five cases of disease, and a 0.1 percent infection for 5,000 people also results in five cases of a disease). The community of Ridge, for example, includes several very large retirement villages. A disease such as WNV that seems to make older people sicker than it makes younger people is of more concern here than in other areas of the County.

If positive results occur in a bridge vector pool, then this too signals a potential need for adult control. If the virus were to be detected in *Oc. sollicitans*, especially, given its very aggressive biting habits and generally large numbers, concerns would be raised. The age of the brood, the time of year (control is more difficult late in the year when the mosquitoes fly at night as less often), and weather patterns (will the mosquitoes be killed by colder weather, or is the heat likely to make them even more active) all need to be factored into the decision.

For EEE, the threat of a bridge vector brood near a cycling center is a strong impetus towards declaration of a health emergency. Generally, Suffolk County has focused on EEE control in the near vicinity of the amplification area. Information gathered through the Long-Term Plan project provides support for the benefits of controlling *Oc. sollicitans* in all areas when EEE threatens, especially where coastal red maple or Atlantic white cedar swamps occur. *Oc. sollicitans* has been persuasively portrayed as the most dangerous and most effective potential vector for EEE. The need to control *Oc. sollicitans* and other bridge vectors generally was underscored through discussions of the potential for dispersing young birds to carry the virus to anywhere along their migration route from natal swamps (where they may have contracted EEE). Any dead horses, or dead farmed pheasants or emus, would also signal the need for a health emergency declaration to address EEE, as all of these quickly succumb to the disease. Disease in horses is of special concern, as it signals presence of the virus in a bridge vector.

Working with SCVC, SCDHS would determine the best application zone, and determine the most appropriate application approach, based on the target mosquito. Hitherto, Suffolk County has focused its control efforts on bridge vectors, meaning that applications are conducted primarily right after sunset, when nearly all important mosquito species are active. Where *Cx.*

*pipiens* is clearly the mosquito of concern, the timing of an application may be retarded to effectuate a better control on this later-flying mosquito. The target area will be based on surveillance data, tempered by natural features (although a waiver from freshwater setbacks will be received for any disease threat application, major bodies of water serve as natural barriers to mosquito migration and so there is no need to apply pesticides over them needlessly) and label restriction areas such as croplands, if they can be avoided. Notices will be filed, and the expedited NYSDEC permit waiver process pursued. Generally, staff from NYSDEC will make themselves available on very short order to enable a coordinated consultation regarding the proposed application zone to address sensitive species and habitat concerns.

Similarly to quality of life applications, the QA/QC team will set out a minimum of two sets of baited CDC traps. Not only will these traps serve as efficacy measures for the treatment to follow, but sampling the trapped populations for species and parity can reinforce – or cause re-evaluation – of the application decision. Parous mosquitoes of concern should be present to cause the application to move forward – although it should be understood that at any given time approximately 50 percent of a *Cx. pipiens* population is parous. Pools from the traps will also be tested for virus presence, although if State facilities are used the results will not be received in a decision-timely manner. Efficacy will be at least partially determined if parity is lower after the application, and, if pathogens were detected in pools before the application, they are not detected in pools after the application event.

It must be understood that all decisions to apply adulticides in Suffolk County are made in the context of an IPM system. Adulticide applications are always the last, least desired control measure. Great efforts will have been made to avoid their use, beginning with public education, source reduction (including water management), and larval control steps. The decisions are not made arbitrarily, but in light of collected data from a surveillance system that has been bolstered from one described as among the best in the country. Adulticiding will only be undertaken to avoid worse consequences, in full knowledge of the benefits and risks associated with the action. These considerations mean that the County decisions clearly comply with all Federal and State guidelines issued to help managers make the best possible choices under difficult conditions.

Figure 5 illustrates the decision-making process followed when adult control is being considered as a Health Emergency measure.

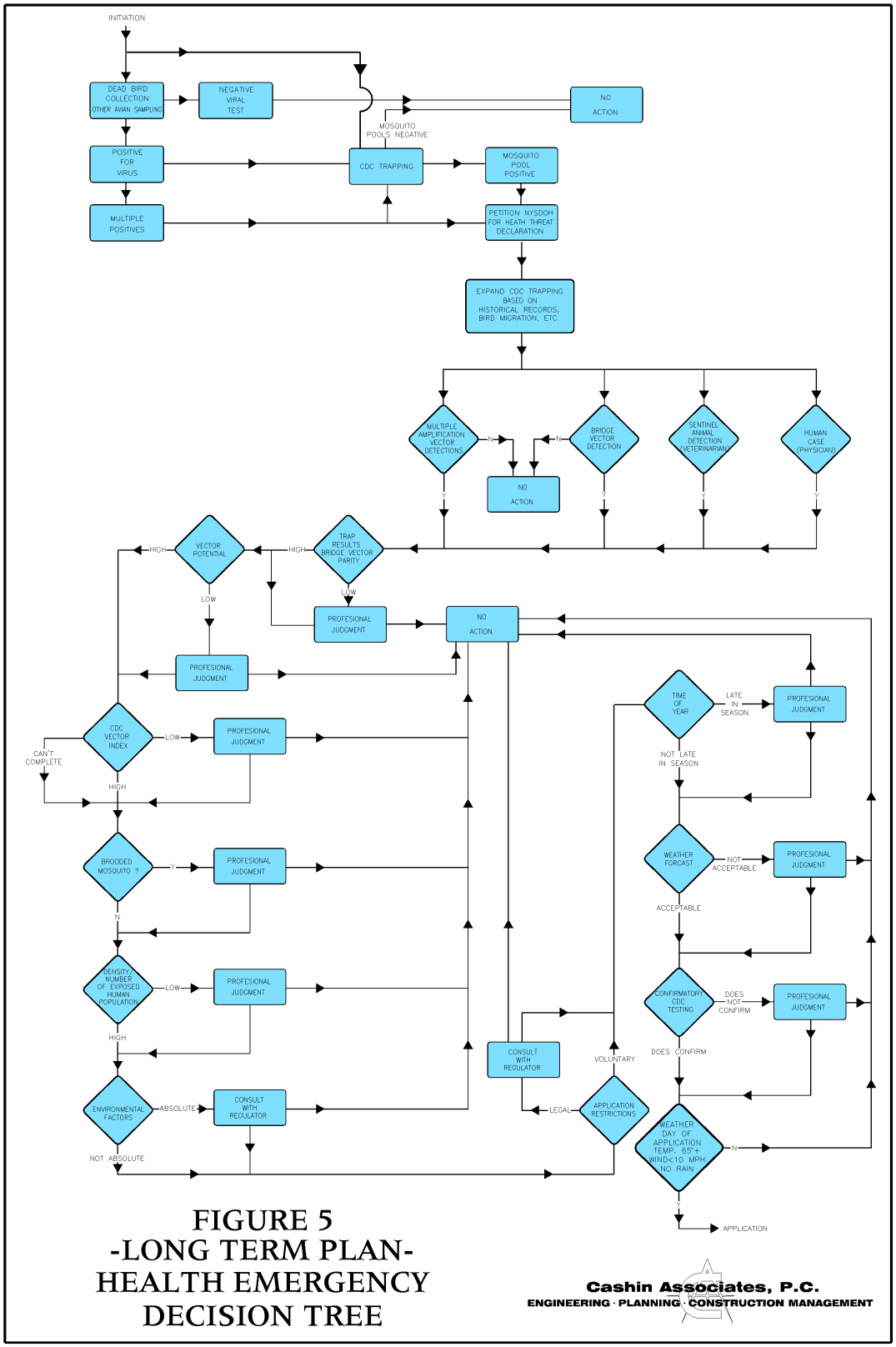


FIGURE 5
-LONG TERM PLAN-
HEALTH EMERGENCY
DECISION TREE

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## 7.4 Selected Pesticides

Pesticides selected by Suffolk County for adulticide control under the Long-Term Plan are all suited for ULV treatments The Risk Assessment and modeling performed (based on EPA guidance documents) indicates no to little detectable human health impacts, and have relatively insignificant ecological impacts. The ecological impacts are further mitigated by the relatively small area that pesticides are applied over, and the distinct probability that the model (which is based primarily on laboratory testing) overestimates the concentrations of pesticides actually delivered to aqueous environments by several factors, based upon testing conducted in association with this project. That being the case, it is clear that a model recalibrated with empirical data would confirm the findings of the Caged Fish study, and find little to no impacts to the ecosystem.

In addition to ULV applications, malathion is approved in New York State by NYSDEC for thermal fogging. Malathion, permethrin, and sumithrin are also approved by NYSDEC for hand-held applications.

Resmethrin, sumithrin, and permethrin, synthetic pyrethroids, and malathion, an organophosphate, have all been selected as the primary adulticide agents for the program. The pyrethroids will all be used in formulations that use piperonyl butoxide (PBO) as a synergist. Natural pyrethrum has received a limited selection as a secondary pesticide, to be used for resistance purposes, and because it has label clearances for use over cropland. Any selected pyrethrum formulation will also contain PBO as a synergist.

*Pyrethroids*

The pyrethroids are synthetic pyrethrin-like materials widely used for insect control. Pyrethrins are natural pesticides harvested from some chrysanthemum plants (mainly *Chrysanthemum cinerarnaefolium*). Chemically, pyrethroids are esters of specific acids (e.g., chrysanthemic acid, halo-substituted chrysanthemic acid, 2-(4-chlorophenyl)-3-methylbutyric acid) and alcohols (e.g., allethrolone, 3-phenoxybenzyl alcohol).

Pyrethrins and pyrethroids have a similar mode of action — they work on the nerve axons by keeping open sodium channels used to propagate signals along a nerve cell. Initially, they cause nerve cells to discharge repetitively; later, they cause paralysis. These pesticides affect both the peripheral and the central nervous systems. When applied alone, pyrethroids may be swiftly detoxified by enzymes in the insect. Thus, some pests will recover unless the effect is augmented. To delay the enzyme action so a lethal dose is accomplished for pest control, a synergist (e.g., piperonyl butoxide) is generally added to pyrethroid formulations to improve efficacy.

Pyrethroids are generally favored above malathion as adulticides. This is because the degradation of pyrethroids in the environment is so swift as to make it extremely difficult to cause any human or environmental impacts, and yet the pesticides still retain efficacy in killing targeted mosquitoes.

*Resmethrin*

Resmethrin is the preferred pyrethroid, and is generally the adulticide of choice for the Long-Term Plan because of its effectiveness and chemical properties. Resmethrin is a broad spectrum pyrethroid insecticide used for control of flying and crawling insects in homes, greenhouses, indoor landscapes, mushroom houses, and industrial sites, insects that infest stored products, and for mosquito control. It is also used for fabric protection, pet sprays, and shampoos, and it is applied to horses and in horse stables.

The risk assessment concluded, at the concentrations resmethrin might be applied in Suffolk County, that no significant health or ecological effects would follow from its use. Resmethrin was identified as potentially impacting night-flying insects, although this appears to result from use of honey bees as the sentinel flying insect based on information availability. Honey bees appear to be more susceptible to impacts from pesticides than other large insects, and so their use may overstate risks. The effect is likely to be short-lived: sampling in California found that following some reduction in insect populations after adulticide events, the populations rebounded in a matter of days. In addition, to further mitigate the potential for any impacts, the Caged Fish study reported much lower concentrations of resmethrin in the water column than were used by the risk assessment model. The lower concentrations are apparently due to quick environmental

degradation of the compound, which was not completely factored into the risk assessment method. In addition, the generally small area of the County that might be affected by resmethrin use should be considered. In 2003, when pesticide applications exceeded recent mean amounts, approximately five percent of the land area of the County was treated, accounting for approximately 12 percent of the County's shoreline. In addition, it is anticipated that the gradual implementation of more progressive water management techniques could lead to a reduction in the need to apply pesticides for mosquito control purposes.

*Sumithrin*

Sumithrin (sumethrin, phenothrin) is currently used in hand-held adulticide applications (current NYSDEC interpretations of the resmethrin label do not allow resmethrin to be used in hand-held applications). This use would continue under the Long-Term Plan.

Sumithrin is a broad spectrum pyrethroid insecticide registered for use against mosquitoes in swamps, marshes, and recreational areas. Sumithrin can also be used to eradicate pests in transport vehicles such as aircraft, ships, railroad cars, and truck trailers, and for institutional non-food use, use in homes, gardens, and greenhouses, and on pets

The risk assessment concluded, at the concentrations sumithrin is applied in Suffolk County, that no significant health or ecological effects would follow from its use. As with all of the pesticides considered by the risk assessors, the risk assessment found there might be impacts to night-flying insects. As discussed above, this appears to result from use of honey bees as the sentinel flying insect based on information availability. To further mitigate the potential for any impacts, the generally small area of the County that might be affected by sumithrin use should be considered.

*Permethrin*

One potential problem with resmethrin and sumithrin is that they are relatively low volume production pesticides. This means if the manufacturer discontinues the product for any reason, the program may be without alternatives that have been reviewed and determined to meet its needs. Therefore, two alternative pyrethroid/pyrethrin products have been identified as meeting the needs of the County, including permethrin.

Permethrin is a broad spectrum pyrethroid insecticide which is used against a variety of insect pests. It is used in greenhouses, home gardens, and for termite control. It also controls animal ectoparasites, biting flies, and cockroaches. Permethrin is additionally used to control insects on a variety of food and non-food products, including on nut, fruit, vegetable, cotton, ornamental, mushroom, potato, and cereal crops, and is the active ingredient in several topical anti-parasitic formulations used in human and veterinary medicine.

There are four isomeric forms, two cis- and two trans-, of technical permethrin. Product formulations can vary greatly in isomeric content.

The risk assessment concluded, at the concentrations permethrin might be applied in Suffolk County, that no significant health or ecological effects would follow from its use. The bee model, which is the basis for this finding, may overstate risks, and sampling data from California indicates any impact is likely to be not measurable within days of the application. In addition, permethrin was found to have the potential to impact aquatic invertebrates. Sophisticated ecological modeling found that the loss of certain invertebrates would not have any greater ecological impacts (i.e., the effects did not propagate up the food chain). Additionally, longitudinal modeling suggested rapid recovery for any affected species, so that full ecological recovery would be expected by spring following any application the previous year. These results are somewhat expected, given that permethrin is not persistent in the aquatic environment and does not bioaccumulate to any significant degree. To further mitigate the potential for any impacts, the generally small area of the County that might be affected by permethrin use should be considered.

*Pyrethrum*

To add to the selection of pesticides available for County use, and to ensure the County has a product that is registered for use in agricultural areas should treatment there be required, pyrethrum has been added to the list of approved products. It is somewhat costly, however, and can be difficult to acquire during high demand periods.

Pyrethrum is a natural, botanical pesticide that is an extract of flowers from certain chrysanthemum species. The flowers are either dried or powdered, or their oils are extracted

with solvents. The resulting pyrethrum extract or powder is composed of individual pyrethrins; including pyrethrin I and pyrethrin II, cinerins and jasmolins, which are the components that have insecticidal properties. Most of the pyrethrin pesticide products that are available also contain a synergist, such as PBO.

Pyrethrum was not as closely investigated as the other three pyrethroids. However, indications are that it is somewhat less toxic than the synthetic pyrethroids. This suggests that, at the concentrations it would be applied in Suffolk County, no significant health or ecological effects would follow from its use.

*PBO*

PBO is a derivative of piperic acid and, as discussed, is generally utilized as a chemical synergist in pyrethroid formulations. Pyrethroid products containing PBO are used to control mosquitoes in outdoor residential and recreational areas, as well as indoors to control insects such as fleas, ticks, and ants. Formulations of pyrethrins containing PBO are also used as a pediculicide to control body, head and crab lice. PBO, in and of itself, at the concentrations modeled to result in the County from applications of PBO-containing pesticide formulations, was found by the risk assessment not to have any significant human health or environmental impacts.

*Malathion*

Organophosphate pesticides consist of a broad class of chemicals used primarily in insect and pest control. These pesticides cover a wide variety of use categories, such as forests and woodlands, greenhouse food and non-food crops, livestock, seed treatments, oilseed and fiber crops, stored food and feed, terrestrial feed and food crops, structural uses, outdoor ornamental and indoor plants, plantscapes, and turf.

Malathion is a nonsystemic broad-spectrum organophosphate chemical that is used in agriculture and horticulture applications. Malathion has been widely used since the 1950s on raw agricultural products including edible grains, fruits, nuts, forage crops, cotton, and tobacco. Malathion has also been used to control parasites of livestock and domestic animals, through aerial applications in and around livestock barns, dairies, poultry houses, and food processing plants. Malathion has widespread use as a ground and aerial application to control

Mediterranean fruit fly (Medfly) and mosquito populations. Malathion is used as a pediculicide in shampoos to treat head lice on children and adults.

Malathion contains approximately five percent impurities consisting largely of reaction byproducts and degradation products. As many as 14 impurities have been identified in technical-grade malathion, including isomalathion and malaxon.

Malathion possesses a relatively low acute toxicity compared to other organophosphates. The risk assessment concluded, at the concentrations that malathion might be applied in Suffolk County, that no significant health or ecological effects would follow from its use. In addition, malathion was found to have the potential to impact aquatic invertebrates – a slightly greater potential than was found for permethrin. Sophisticated ecological modeling, based on the permethrin impacts which were similar in scope, found that the loss of certain invertebrates would not have any greater ecological impacts (i.e., the effects did not propagate up the food chain). Additionally, longitudinal modeling suggested rapid recovery for any affected species, so that full ecological recovery would be expected by spring following any application the previous year. These results are somewhat expected, given that malathion is not persistent in the aquatic environment and does not bioaccumulate to any significant degree.

It should be understood that public perception of the toxicity of malathion is based largely on work conducted on agricultural pest control applications. The label rates for malathion for use as a mosquito control pesticide are lower than for its use against general agricultural pests. Mosquitoes are more sensitive to pesticides than most other insects. This means that malathion is applied for mosquito control at much lower concentrations than it is for agricultural pest control, and so any potential impacts are much less as well.

### 7.5 Formulations

Scourge 18-54 will be the resmethrin product used by the County. Product labels contain the signal word "CAUTION." The product will be applied either by ground or aerial ULV at label rates.

Anvil 10+10 will be the sumithrin product used by the County. It has a label that contains the signal word "CAUTION." Sumithrin will be applied primarily through hand ULV applications, although it may also be used for ground or aerial ULV uses.

Commercially available permethrin products include Permanone®, and Aqua Reslin®, but as the patent has expired, brands are proliferating. The County has not yet selected a preferred provider. Permethrin labels may contain either the signal word "WARNING" or "CAUTION," depending on the formulation. Permethrin is not a primary use adulticide for the County, but rather will be used if other pyrethroids become unavailable.

Commercially available pyrethrum products include Pyrocide, and Pyrenone. The County has not yet selected a preferred product. Product labels contain the signal word "CAUTION." Formulations generally contain five percent pyrethrins with PBO at a one to five ratio. They are applied as a ULV application, and are expensive compared to other products, and sometimes are difficult to obtain because demand outstrips supply. Pyrethrum will be used for resistance purposes, and over agricultural areas, if required.

Fyfanon will be the malathion product used by the County. It is one of the most widely used adulticides in the country, primarily because of its lower cost compared with other approved adulticides. The label contains a "CAUTION" warning indicating that it is only a slightly toxic material. Malathion is generally used against all mosquito species of concern, primarily as a ground ULV application, needing no mixing or dilution. For thermal fog applications, malathion is diluted six to eight oz. /gal. with a suitable oil carrier, and applied at up to 40 gal./hr. with a vehicle speed of 5 mi./hr., or multiple thereof. Malathion can be applied using ULV aerial application techniques. Malathion will primarily be used for resistance purposes, or if thermal fogging is necessary.

## 7.6 Application Methods

The County uses three application methods, with variations associated with several of the different means. In all instances to address resistance concerns, and to achieve the best possible results, the County will apply the pesticides at the maximum rate allowed by the product label.

There are some general constraints on all application events. Low temperatures inhibit mosquito activity; SCVC has set 65 degrees F as the minimum for operations. Winds cannot exceed 10 mph, as mosquito activity is lower when conditions are windy, and the pesticides will disperse too quickly. Mosquitoes are not as active in the rain, and rain will remove pesticides from the atmosphere, making the application pointless. Therefore, rain is counterindicative for applications.

On Fire Island, where vehicle access is difficult, a golf cart type platform is used to hand haul a London Aire Colt Hand Portable ULV Aerosol Generator to apply adulticides. This is a ULV treatment. Hand applications are only conducted as quality of life treatments. Health emergency applications over Fire Island would most probably be conducted by helicopter, as the scope of the event would almost certainly exceed one community. Applying adulticides by aircraft is one way that the County's virus response plan differs from NYSDOH guidelines. State guidelines suggest using trucks to apply pesticides; Suffolk County prefers aerial applications in response to Health Emergencies (see below for a discussion of some of the factors that bear on this decision).

The planned hand-held application will be discussed by managers and applicators prior to the applicators leaving SCVC offices. The application route will be specified, along with any setbacks, no-spray properties, and other areas that will not be treated. The specific path to be followed will not be mapped, but will depend on operator judgment (resort communities present special problems such as parties and other congregations that need to be adjusted for in the field). Prior to initiating treatment, the crew would conduct spot larviciding as needed, and also conduct a landing rate survey to ensure *Oc. sollicitans* mosquitoes are still present.

The protocol to ensure label compliance requires a "walking pace," estimated to be approximately two mph. A two-man crew will conduct work, one ensuring that the applicator functions properly, and the other noting the route that was being followed, and anticipating obstacles and areas requiring the applicator to be shut down, including pedestrians or people out of doors. It is SCVC policy not to spray where people may receive direct exposures. Spraying begins at dusk, or sometimes a little before (sumithrin, the preferred insecticide for hand-held applications, degrades readily and rapidly in sunlight, and so such applications are less effective in daylight).

The hand-held routes are not performed with GPS equipment, and so the application route needs to be filed with GIS staff for mapping. Enhancement of SCVC equipment to allow GPS tracking of these sometimes intricate routes would be beneficial.

Setbacks from salt water are currently set at 100 feet. Setbacks from fresh water wetlands are set at 150 feet. These setbacks were negotiated with NYSDEC as a means of addressing perceived needs to regulate adulticide applications that fall within the 50 feet regulated buffer surrounding NYSDEC-mapped fresh water wetlands, and to similarly abide by label restrictions regarding applications directly to water. The specific modeling results associated with the risk assessment, and the risk assessment computation of ensuing impacts, provide a means to reconsider these bounds. SCVC should initiate discussions with NYSDEC staff at its earliest opportunity to determine of the setbacks need to be increased to provide more protection to the aquatic communities, or reduced to provide more complete control, especially in what may be key buffer area adult mosquito habitat.

On the mainland, essentially all vector control efforts are conducted using truck applications. Almost all air applications would require receiving a waiver from fresh water wetlands regulations, which NYSDEC has not been willing to issue for non-health emergency adulticide efforts, pending an EIS. SCVC pickup trucks are fitted with London Fog Model 18-20, ULV truck mounted aerosol generators that are equipped for adulticiding with an Adapco Monitor III GPS tracking and computer logger for ground-based adulticiding. The equipment is calibrated prior to the beginning of the season. Droplet spectrums are rechecked periodically. For mosquitoes such as *Oc. sollicitans* and *Ae. vexans*, the nozzle angle is set at 45 degrees to create a lower pesticide cloud. Should applications for canopy-dwelling mosquitoes (such as *Cx. pipiens* and *Cs. melanura*) be desired, the angle of the nozzle will be increased to 60 degrees from horizontal.

Maps of the target area will be generated by GIS prior to staff leaving SCVC offices. The maps will have no-spray lines, setback boundaries, and buffers surrounding other areas of concern clearly marked with strong colors to ensure the notations are discernable within the truck at night. SCVC tries to be sensitive for individual community needs. For example, spraying in

Westhampton Beach was rerouted to avoid exposure for worshippers walking to synagogue one Friday.

The operation requires two people. One will operate the truck and application machinery. The other will be responsible for route maintenance and avoidance of obstacles, including timely warning of pedestrians or people in yards (it is SCVC policy not to spray people in the outdoors).

Spraying usually will begin at dusk, or sometimes a little later, and will continue for several hours to complete the route. This is for several reasons:

- Resmethrin, the Long-Term Plan preferred insecticide, including for truck applications, degrades rapidly under daylight conditions, and so efficacy would be lost through daylight applications.

- Most mosquito species, especially *Ae. vexans* and *Oc. sollicitans*, are most active at that time.

- Waiting for dark tends to minimize pedestrians and other outside venturers.

Pre-dawn applications target the same mosquito species, but often would be conducted at temperatures that do not meet operational requirements. Thus, it is proposed that almost all applications occur in the evening. Mosquitoes active later in the night, such as *Cx. pipiens* and *Cs. melanura*, could be targeted by having the application start several hours later (around 10 pm).

The vehicle must be moving at least seven mph for the sprayer to operate (that allows for proper dispersion of the spray cloud), and will cease operations if 20 mph is exceeded. The target speed is 10 mph. The sprayer is computerized, and so will calculate the release rate necessary to meet label limits. The sprayer also generates a GIS map of the route it followed, including on/off sites. It calculates the amount of pesticide applied. This information is downloaded on completion of the application, and is verified by the field crew prior to finalization by data management staff.

Setbacks from salt water are currently set at 100 feet. Setbacks from fresh water wetlands are set at 150 feet. SCVC will discuss the utility of these limits with NYSDEC in light of the risk assessment modeling and ecological risk calculations.

Some of the ground-based application events are under Health Emergency conditions. For those events, SCVC has almost always received a waiver from fresh water wetlands restrictions, and need not abide by the voluntarily assumed setbacks for either fresh or salt water. As a practical matter, setbacks often ensue in any case due to the relationship between roads and waterways (roads seldom follow waterways without a buffer of some kind, and very often a residential lot is a very substantial buffer). In addition, SCVC voluntarily adheres to measures requested by NYDEC to limit environmental impacts, even when not required to by law, provided that can be done without compromising effectiveness. For Health Emergency applications, no-spray list restrictions need not apply, if waived by the Commissioner of SCDHS. Although this is not required by law, SCVC attempts to contact no-spray list members in an area targeted for an emergency treatment, in order to allow these individuals to take protective measure such as staying indoors, if they so choose.

Aerial applications are almost always under Health Emergency conditions. This is because it is generally impossible to set helicopter swaths to abide by the NYSDEC setbacks, and because many quality of life application events can be more limited in area than those conducted with a focus on addressing arbovirus presence.

The area selected for treatment is defined differently for each application mode.

- Hand held applications (strictly on Fire Island) cover the entire residential area in each community, excepting housing in buffers (for wetlands, open-water, and no-spray addresses), and the specific addresses on the no-spray list.

- The general area for a truck application for vector control purposes is generally defined by the locus of complaints. Complaints, while not sufficient to cause an adulticide application, are the most efficient means of defining areas with higher mosquito biting rates. Once a general area of interest has been defined, the application area is refined by including modifiers such as mandatory and voluntary setbacks (such as those around

wetlands, open water, and no-spray list members), no-spray list addresses, environmentally-sensitive areas, farms, and other areas that should not be treated. The area road network also factors into the application area determination. This is because issues such as large distances between streets, so that the application will not cover contiguous areas and so be less effective, may determine areas that it is not worthwhile to apply pesticides over. The tentative application determination is reviewed with SCDHS (typically, the ABDL director) for concurrence, and is used as a basis for public noticing. Application areas may continue to be refined until just before the run begins, although early determinations have the benefit of resulting in better route maps for the applicators.

- Health Emergency application areas are determined by SCDHS staff in consultation with SCVC. A focus of the determination is the extent of viral presence. The area to be treated also is set based on assumptions regarding the ranges of the potential human vectors. Complaints are sometimes referenced, as these can help identify areas where bridge vectors are especially active. Consultations with FINS, if required, can further define the application area. NYSDEC is routinely involved in the application area determination because there will generally need to be a waiver of NYSDEC Freshwater Wetlands regulations. Practical considerations that need to be addressed regarding the capabilities of the helicopter that will apply the pesticides usually lead to a final application area determination. The practical considerations include (but are not limited to) the amount of pesticide that can be loaded onto the aircraft, the area that can be covered, and the geometry associated with making turns and applying pesticide in swaths. With the Adapco Wingman system operating, the actual final route followed by the aircraft will be determined in the area, due to real-time feedback from the model, based on area weather observations and project placement of the released pesticide. The Wingman model may also prove to be useful in developing efficient application area determinations.

The County uses a helicopter for aerial applications. It is a 3,200 lb. aircraft with an 18 foot six inch radius rotor operated by North Fork Helicopters, Ltd., of Cutchogue. The helicopter is fitted with two Beecomist nozzles nine feet from the centerline, oriented straight back. They have a flow rate of 25.2 oz/min. Prior to 2005, the applications means was by 300 foot swath

released from 75 feet to 150 feet above the canopy at 70 mph. Modeling results indicated that off-target drift could be minimized by applying a 600 foot swath at 35 mph. It has been subsequently determined that in most situations, it will not be possible to slow the helicopter to 35 MPH for flight safety reasons. In addition, concerns were raised that slower speeds could increase droplet deposition, which could lead to greater non-target impacts. Instead, off-site drift will be reduced through the use of the Adapco Wingman system. Because the aerosols are intended to be composed of droplets so small they tend to remain suspended (they are brought to the ground more by turbulence than gravitational effects), drift caused by winds sometimes means the maximum pesticide concentrations do not occur in the center of the target area. This can be addressed through dispersion modeling, and leads to purposeful upwind offsets to bring the pesticide fully into the target area. To optimize this process, SCVC has acquired a state-of-the-art in-aircraft navigational-modeling system, produced by Adapco (the Wingman system). This system provides instantaneous course corrections to the pilot based on real time ground and balloon weather information generated in (or near to) the application zone.

The general flight pattern will be set with the pilot at the application area prior to loading pesticides into the helicopter, although the final route will depend on the on-board modeling output. The Adapco system, similar to the GPS guidance system in use at this time, will produce flight paths with on/off markings, and compute the amount of pesticide applied. The Adapco Wingman system ground module can also be used as a means of setting the proposed application area by forecasting an optimal swath pattern, given estimated weather. The timing of application events will follow those set for truck applications, above.

### 7.7 Resistance Concerns

All pesticide uses have an inherent risk of generating resistance in the target species. Resistance arises by selecting for individuals that are less susceptible to the pesticide being used. Applications that are not powerful enough are dangerous, because they will kill all of the most susceptible individuals while allowing those with less susceptibility to provide the next generation.

Resistance is thus minimized by using appropriately high enough concentrations of pesticide. Resistance can also be minimized by alternating pesticides applied in order to reduce the

potential of repeated use of only one formulation to select against that formulation. The probability of a mosquito being less sensitive to two different insecticides is reduced in comparison to the chances of being less sensitive to one, especially if they have different modes of action.

The formulators of the Long-Term Plan believes that the Caged Fish experiment justifies a reliance on resmethrin as an adulticide. Sampling associated with the experiment showed that the compound degraded extremely quickly. This means that it is extremely unlikely for it to have any environmental or human health impacts. It is not known if other modern adulticides degrade as quickly.

Reliance on one compound does raise resistance concerns. These are mitigated by the few adulticide applications made by SCVC over the course of a year, and by the small area impacted by adulticide events. This allows for a great many adult mosquitoes to reach maturity without contact with resmethrin. These mosquitoes will serve as a reservoir of genes to ensure that resistance does not become a dominant trait in Suffolk County mosquito populations.

However, this informal check on resistance is not sufficient. Therefore, SCVC should develop an improved resistance monitoring program. This kind of work is very specialized, and needs to be exceedingly precise and refined. This is because learning that the County has developed a sizable population of resistant mosquitoes would mean that it would be difficult to implement measures to relax selection and allow the return of susceptible mosquitoes. Good resistance monitoring determines if a problem is developing, and allows actions to be taken so that all pesticide tools can continue to be effective in achieving desired ends. New Jersey has an especially sophisticated program facilitated by Rutgers University Mosquito Research and Control Unit, and it is recommended that the County enter into a program with that group. The larger mosquito management companies (such as Clarke Mosquito Control) also offer such services.

### 7.8 Efficacy and Efficacy Testing

Adulticides are generally very effective. Indeed, the primary complaint about adulticides is a claim that they have negative impacts on too many unintended organisms. Under the best

application conditions, it has been clearly demonstrated that all of the adulticides under consideration eliminate between 90 and 99 percent of mosquitoes within the treatment area (one to two orders of magnitude population reduction.

However, every insecticide application can be affected by a myriad of factors, including to much or too little dispersion due to weather, blockage of the insecticide from the target mosquitoes by foliage or buildings, or simple human error. Professional care and conduct address the latter sources of error in most instances, but sometimes natural conditions cannot be overcome, and the application fails to achieve its desired end.

In order to explicitly validate the County's adulticide program, the County should perform efficacy tests in association with every adulticide application, save those in the Fire Island communities. Two baited CDC traps would be set prior to every application, one in a control area, and one in the middle of the target zone. The samples from the night before would then be compared to samples from the night after. Adjustments to the data sets would be made based on the control site results. The focus of the results would be on reductions in numbers of mosquitoes, and, when a health emergency has been declared, reductions in the parity and infection rates for the target species.

It must be understood that some mosquito species have a very quick generation time when the weather is warm and conditions are right; other mosquitoes are capable of migrating miles from their breeding sites in search of blood meals. So it is also possible to have an application of pesticides that kills the adults in a particular area, but still have a mosquito problem soon after that application as others migrate in. Therefore, because there is a lag from when the mosquitoes may or may not have been killed by the pesticides, and when efficacy data are collected, negative results for efficacy testing do not necessarily indicate that the pesticides did not succeed in killing mosquitoes in the target area.

SCVC also maintains a colony of *Cx. pipiens* in the laboratory. These mosquitoes are more usually used for laboratory investigations of such issues as pesticide effectiveness. However, mosquitoes can be put into cages, and set outside at appropriate or important sites to document adulticide application effectiveness. The results are generally recorded as the percent of exposed mosquitoes that succumb over a two or three hour interval. There are various technical issues

associated with such studies, but nonetheless they are the general industry standard for assessing adulticide application effectiveness. This is because (for one) there is little chance that changes in weather immediately after the application will influence the mortality rate of the caged mosquitoes, whereas this is a common complication with trap tests. Caged mosquito testing is much more labor intensive than trap tests. The information generated by cage testing only bears on the immediate effectiveness of the application, and so is either very specific to the application, or is limited to the immediate time frame of the application (depending on one's point of view). Additionally, trap data have applicability for other aspects of mosquito control work. In sum, SCVC would conduct relatively few cage tests in any seasons (one or two are likely to be standard).

Each aerial application efficacy result set should be released within a week or so of the application. Results should also be released on an annual basis for the program as a whole. The individual events could be discussed in detail at that time.

# 8. Administration

## 8.1 Organization

SCVC works closely with SCDHS to ensure ongoing health related surveillance input for SCVC decisions are made. SCDHS operates the ABDL at the Yaphank facility and is also responsible for medical surveillance, environmental monitoring, community outreach and public education, while the SCVC concentrates its efforts on mosquito control. An additional cooperative relationship exists between SCVC and SCDHS and NYSDOH to alert the County of statewide occurrences of WNV and EEE.

In the future, it is recommended that SCVC concentrate its resources on surveillance activities that involve assessing the population density and distribution of larval and adult vectors, while SCDHS continues to monitor and locate disease activity in mosquitoes and sentinel animals such as birds. Mosquito population surveillance (New Jersey traps, larvae, complaints, special traps set in problem areas) is intimately associated with the control operation and should be funded by SCDPW and be primarily a SCVC responsibility. While both SCVC and the ABDL will continue to be involved with mosquito surveillance, SCVC surveillance staff should be organized as a work unit that collects and receives New Jersey trap collections, larval samples from the SCVC crews, and conducts special larval and adult collections designed to manage the control effort. The ABDL will employ more technically demanding sampling methods, such as cold chain, which involves keeping specimens cold to prevent viral degradation.

In order to implement the recommendations of this Long-Term Plan, it is expected that significant additional resources of both personnel and equipment will be approved by the County to improve vector control practices in accordance with the findings of this study. SCDPW and SCDHS have prepared specific proposals detailing the number and titles of new personnel required to implement this program. The actual creation and filling of these proposed positions, however, is dependent upon the County budget process.

*Administration*

The Vector Control Superintendent will be responsible for the overall administrative supervision and the supervision of mosquito management actions. Because of intense regulatory scrutiny, the Superintendent will particularly administer aerial larvicide and all adulticiding operations. There will be expanded responsibilities for this position as the operations of SCVC become more technically complex. New oversight by various committees and cooperative outreach to towns and other government agencies will also increase the workload. The expanded mandate with respect to wetlands management will be an additional set of new responsibilities. The end of the Long-Term Plan project should facilitate the time and efforts necessary to deal with these new expanded duties. The existing duties of this position are:

- Provides overall administrative supervision and operational oversight of mosquito management actions and wetlands projects.
- Coordinates activities of units with Division.
- Evaluates Division operations and effectiveness.
- Coordinates with other County Departments, especially SCDHS, the ABDL, and other government agencies.
- Interacts with public.
- Interacts with professional associations and other mosquito control agencies to ensure the program operates to current standards and stays abreast of developments in the field.
- Serves as technical resource for staff.
- Responsible for Division response to litigation, including coordination with counsel, testimony, and other legal issues.
- Oversees aerial larviciding based on surveillance reports.
- Issues public notice of aerial larviciding.

- Oversees adulticiding and makes determination of need based on a range of surveillance and other factors.
- Directs aerial adulticiding operations.
- Issues public notices for adulticiding.
- Designs water management projects.
- Selects water management equipment.
- Obtains Article 15 Aquatic Pesticide permits and Fresh Water Wetland permits.
- Serves on County Pest Management Committee.
- Prepares Annual Plan of Work and budget. It is anticipated that the success of the Long-Term Plan may reduce responsibilities in this area somewhat, as future Plans of Work may cite the Long-Term Plan extensively instead of preparing de novo material each year.
- Supervises the SCVC surveillance effort to ensure that all control is surveillance-driven.
- Oversees the preparation of the Annual Wetlands Strategy Plan.
- Assists in the preparation of annual efficacy reports.
- Oversees the implementation of the Long Term Plan.
- Oversees preparation of the triennial Long-Term Plan compliance report.

SCVC will use Long-Term Plan to assist in the preparation of Annual Plan of Work. The Plan of Work is a written description of SCVC's purpose, history, current operations, and goals for the following year and the future. The Plan of Work is prepared by the Superintendent and submitted to the Legislature in October for approval in November. Legislature approves SCVC plan of work each November as part of the County Budget.

General administrative support for SCVC will come from the SCDPW Administration and will include duties such as payroll, purchasing, etc. This unit will take service requests and handle other public contact, and support litigation response by providing files and other pertinent information. Given the increased activities proposed for SCVC, there will be a need for additional administrative staffing. The existing staff includes one Purchasing Technician and one Clerk Typist. The existing duties of the Purchasing Technician and Clerk Typist are:

- Taking service requests and other public contact.
- Sending out routine notices.
- Various administrative tasks, such as purchasing, personnel, vehicle management and other administrative details.

No new duties are proposed. However, the greatly increased activity will require additional staff. Under the Long-Term Plan, there will be more time consuming tasks of public outreach and contact, and the new work units will add to the administrative support workload for which budgetary support will be required.

*Technical Services and Compliance*

The Technical Services and Compliance unit will coordinate and approve all data collected by the SCVC, while providing technical support for the other units. This unit will oversee all SCVC activities for environmental compliance and ensure that all required reports are prepared. This unit will also be responsible for some of the technically demanding tasks of SCVC, such as equipment calibration and adulticiding. All data collected by SCVC must be made immediately available to the ABDL. To accomplish this, SCVC will task its Programmer/Analyst and other staff with developing improved data systems to facilitate rapid collection and dissemination of adult and larval data over the network. Access to these data will be given to the ABDL.

There is a need for a highly trained and experienced Principal Environmental Analyst to handle these tasks and oversee day-to-day operations, since it is not possible for the Superintendent to perform these tasks and also handle administrative duties. Given the high visibility of the program, the extensive set of laws and regulations that pertain to it, and the high likelihood of

continuing litigation, maintaining proper data systems and oversight to maintain and document compliance is a critical activity. At the current time, the Technical Services and Compliance unit consists of:

- one Principal Environmental Analyst
- one Programmer/Analyst
- one Biologist (this position will be moved to a new Natural Resources Unit, if created)

The existing duties of this unit are:

- Overseeing control operations (normally limited to stand-in for Superintendent during his absence).
- Supervising wetlands projects.
- Obtaining water management permits and conducts other activities to maintain environmental compliance.
- Preparing permit maps and other materials (to be transferred to Natural Resources).
- Overseeing heavy equipment unit (to be transferred to Natural Resources).
- Assisting in viral surveillance (to be transferred to ABDL).
- Preparing maps and aerial photography for use by other units.
- Operating SCVC GIS.
- Developing GPS/GIS and adapting to Vector needs.
- GPS mapping for water management (to be transferred to Natural Resources)
- GPS/GIS for larvicide application (to be transferred to Mosquito Surveillance and Control).

- Designing, operating and maintaining data systems to ensure relevant and required data is obtained and is available for analysis.
- Providing equipment calibration and documentation.
- GPS/GIS for ground adulticiding.
- Gathering information from field and preparing State pesticide reports.
- No-Spray list maintenance, management, and compliance.
- Complying with Freedom of Information Law and discovery requests for information.
- Alternate to Superintendent for public notices.
- Alternate to Superintendent for aerial larvicide applications.
- Alternate to Superintendent for adulticide applications.
- Technical support for litigation.
- Interacting with Long Term Plan
- Special sampling of problem areas and other needs (to be transferred to Mosquito Surveillance and Control)

A GIS specialist will be required to: receive data from field crews and integrate it into the overall system and to assist the Mosquito Surveillance and Control and Natural Resource units in acquiring GIS/GPS data and provides information for reports.

The proposed new duties for the Technical Services and Compliance unit that will require increased staffing are:

- Operate the ADAPCO air system.
- Prepare operational summaries for reports and public outreach.

- Develop priority lists for water management actions.
- Act as technical resource for Mosquito Surveillance and Control and Natural Resource staff.
- Act as staff for wetlands committees.
- Develop data systems for monitoring and compliance.
- Web Master for improved public outreach.
- Outreach to towns, other governmental agencies, and non-governmental organizations

*Mosquito Surveillance and Control*

The Mosquito Surveillance and Control unit will be reorganized and upgraded to process more information to guide control decisions and evaluate the control efforts. This unit will guide the larval control program. It will determine the need for adult control and refer that task to Technical Services and the Superintendent for action. Existing staffing is not sufficient to provide trapping data in all locations where adulticiding occurs. Greater follow-up and a new quality control effort are to be implemented will also require additional resources. Similarly, as more information is to be provided to the public to support the program, this information must be compiled and put in a useful format. This information would also be used in determining the need for additional control if pathogens are present. This unit could assist the ABDL in viral surveillance during peak times and emergencies, but these duties would normally be transferred out of SCVC to the ABDL. The information gathered would also be used for compliance reports. ABDL data should be made available to SCVC, to the extent permitted by medical confidentiality laws. Collection of field samples should be coordinated between SCVC and the ABDL to avoid duplication of effort.

The Mosquito Surveillance and Control unit currently consists of:

- one Vector Control Supervisor
- one Vector Control Aide

- one Laboratory Technician (vacant)
- one Auto Equipment Operator (seasonal)

The existing duties of this unit are:

- Operate New Jersey trap network, count samples and enter data.
- Identify larvae collected by field crews.
- Assist the ABDL in virus surveillance (to be transferred to upgraded ABDL except for emergencies).
- Assist with special studies.
- Maintain a mosquito colony.

The proposed new duties that will require additional personnel for the Mosquito Surveillance and Control unit are:

- Overall responsibility for assessment of vector mosquito populations, determining the need for vector control, directing control efforts and evaluating the effectiveness of control measures.
- Operate an expanded network of New Jersey light traps, analyze samples, enter data into appropriate systems and analyze and interpret results
- Review and analyze service request data to identify problem areas.
- Refer areas requiring adulticiding to Superintendent and Technical Services and Compliance.
- GPS/GIS for larvicide application (transferred from Technical Services and Compliance).
- Conduct surveys of larval abundance, distribution and species composition using samples gathered by field crews and conduct supplemental sampling.

- Carry out special adult or larval collections to investigate problems.
- Carry out special surveys of problem larval habitats such as *Cq. perturbans*.
- QA/QC evaluation of control efforts using special trapping or other sampling measures.
- Use service request data to ensure problem areas are identified and addressed.
- Provide data on sampling and applications for compliance reports.
- During winter, evaluation of program effectiveness and data analysis.
- Conduct special studies on new materials and/or innovative control measures.
- Conduct biocontrol using fish or other predators.
- Identify priority areas for water management measures.

*Natural Resources*

The Natural Resources unit, which is a newly proposed unit, will be responsible for the implementation of an expanded, far more sophisticated, progressive water management program. This will require more attention to natural resource issues and more detailed project planning, documentation, and evaluation. In particular, even the most minor maintenance actions will require more documentation, and simple culvert replacements and upgrades will require engineering-level drawings. Survey skills will be necessary, at a minimum, and complex projects may require sophisticated engineering design. Engineering skill may also be required for SCVC input into USEPA Phase II Stormwater Management actions. Even if other agencies have available resources to perform project monitoring, SCVC will need to guide and evaluate these efforts. New personnel to staff this unit are needed for the following duties:

- Oversee collection of natural resource data for permitting, compliance and monitoring, and for supervision of wetlands projects.

- Assistance in surveillance and quality control during the summer months, especially evaluation of control measures, and to assist Director with supervision of wetland projects.

- Design of water control structures, with a focus on determining the appropriate sizes of culverts and tidal channels. Preparation of project drawings, especially for more complex projects. Engineering design of more complex structures such as tide gates.

- Surveys of wetlands projects and water control structures and preparation of project drawings, e.g., drawings for standard structures such as replacement culverts.

Proposed duties of the entire unit are:

- Responsible for collection of natural resource and mosquito data for permitting, compliance and monitoring, as well as wetlands stewardship activities.

- Design and engineer wetlands management projects.

- Provide all necessary project plans and supporting information for permitting and compliance.

- Supervise construction of wetlands projects.

- Document all water management activities and provide data for information systems.

- Conduct monitoring and assessment of County wetlands, including use of remote sensing.

- Provide information to allow setting priorities for water management.

- Assist landowners in monitoring efforts.

- Evaluate effects of water management activities.

- Conduct special studies for non-target effects.

- Act as staff for wetlands committees.

*Field Crew and Water Management*

The Field Crew and Water Management unit will perform the daily technical tasks such as water management and pesticide application for SCVC. This unit will also conduct larval surveillance, assist with adult surveillance, and respond to service requests. Thus, this unit will represent the working component of the program, while serving as its sentinel.

Existing staffing for this unit is:

- five Vector Control Labor Crew Leaders
- one VC Supervisor (temporary for Fishers Island)
- two Temporary Labor Crew Leaders (Fishers Island)
- one Vector Control Aide
- three Construction Equipment Operators
- three Heavy Equipment Operators
- 18 Auto Equipment Operators (including two currently vacant positions)
- four Laborers (including one currently vacant position)

The proposed new duties that will require additional personnel for the Field Crew and Water Management unit are:

- Increase larval surveillance to assist with guiding control decisions
- Increase reliance on larviciding and water management to reduce adulticiding
- Increase control of breeding in stormwater structures, such as catch basins

*Arthropod-Borne Disease Laboratory (SCDHS)*

The ABDL presently operates using a combination of SCDHS and SCVC staff to conduct viral and population surveillance. This practice creates a situation whereby the same staff members collect information related to the control aspect of the program as well as information for the disease aspect of the program. This results in programmatic competition for limited staff time. The ABDL and SCVC both need increased resources, and especially staff, to implement the draft management recommendations. Given the high priority of viral surveillance, resources are often not available to provide data and analysis directly related to the control program. In addition, the lines of supervision, control and budget are complex and not conducive to optimal use of resources. Under the proposed organization, the ABDL would be clearly tasked with viral surveillance and would control all resources needed to conduct that work. This would allow assignment of SCVC staff for activities critical to that unit, and relieve the ABDL of tasks more directly related to the control program than to disease surveillance. When the ABDL identifies viral activity, the information can be easily combined with that collected by SCVC to guide response measures. In fact, increased and more sophisticated surveillance by SCVC on vector populations should lead to a more targeted response to viral activity.

SCVC staff will manage its workload to allow it to assist with viral surveillance, if needed, during the peak viral season (August and early September). However, peak viral season historically has coincided with the times when the demands on SCVC staff associated with the complexities involved in adulticide planning, permitting, and follow-up have also peaked. If this seasonal pattern continues under the Long-Term Plan, it would limit SCVC's ability to provide assistance. ABDL staffing levels should not be based on an assumption that SCVC staff will be available for all peak viral surveillance workloads. During times of a declared public health threat, all surveillance and control resources will be controlled by SCDHS, as outlined in the County Charter. High priority viral sampling may have to take priority over other surveillance. SCDHS will be required, of course, to continue to ensure that all aspects of the Long Term Plan are complied with, to the maximum extent practical.

Staff from this unit will report to SCVC on a daily basis, but may report to the ABDL during emergencies.

The existing staff of the ABDL and their corresponding duties are:

- One Laboratory Director: Responsible for overall administration and supervision of laboratory.
- Two Entomologists: Perform infectious agents surveillance and testing.
- One Biologist: Performs dead bird testing using the RAMP system as well as assist with infectious agent surveillance and testing.
- One Program Aide: This staff member serves as the Health Safety Officer, performs budgetary tasks and attains the necessary permits for laboratory function.

As a supplement to the existing positions listed above, significant new staffing resources will be needed to implement the proposed management plan recommendations for the ABDL. The department has a specific proposal for consideration during the county budget process. All sampling, testing, and analysis for the presence and distribution of mosquito-borne pathogens should be transferred to a stand-alone ABDL with full capabilities to conduct this work. Staffing level and other resources, such as vehicles, must be sufficient to provide this capability. The level of resources will depend to some extent on how much testing will be done in-house. Data from this effort would be combined with SCVC data on vector populations, plus human surveillance conducted by SCDHS, to assess the risk of mosquito-borne disease and to determine if measures beyond general vector control (such as special adulticiding) are required. Resource sharing between SCVC and ABDL is possible and necessary. Examples include deploying and recovering traps. There are, nonetheless, advantages to a more formal division of labor between SCVC and the ABDL. The current situation has the same staff collecting information related directly to control and information for virus survey. This can lead to competition for limited staff time. Since virus sampling has the highest priority, data collection related to the need for and the evaluation of control efforts may not be completed. The best way to ensure more data is collected to assess the need for control and to evaluate any control efforts, while not decreasing pathogen sampling, is to provide the resources that allow the two programs to operate independently.

In summary:

- It makes organizational sense for SCVC to collect and manage the data it needs for its day-to-day control operation.
- It makes organizational sense for SCDHS to survey for human pathogens.
- Most of SCVC's effort is preventative and conducted based on the abundance and distribution of vectors, rather than in direct response to pathogens, and so is conducted prior to and independent of the detection of pathogens.
- SCVC's sampling needs are directed mostly toward those areas where mosquitoes are most abundant, while the ABDL is most concerned with determining where pathogens may be present.
- Vector sampling is time-critical, in that daily control decisions depend on it.
- The samples collected for monitoring purposes by SCVC do not require being kept in cold storage after collection, as those collected by the ABDL for viral detection do.
- A division of labor between the sampling programs allows each one to operate in a manner that optimizes its efforts.

The current level of coordination between the ABDL and SCVC regarding adulticide decisions when there is no declared health threat appears adequate. The standard e-mail notices for the adulticide operations should include a brief description of the surveillance indicators for the operation, a practice that has begun this season. During a declared health threat, adulticide decisions are controlled by SCDHS as required by the County Charter. It has been standard practice at these times for SCDHS to delegate control decisions based on mosquito population levels to the SCVC Superintendent. Decisions regarding applications in direct response to viral findings and human disease risk have been made by SCDHS, with technical input from SCVC.

The County currently has a capital project in progress to upgrade SCVC facilities and the ABDL. Upgrading the laboratory will provide it with the BSL-3 certification required to become fully autonomous. Obtaining this certification would allow samples to be processed in-house,

decreasing the amount of time required to obtained results significantly. The BSL-3 certification would also provide the ABDL with the ability to test samples for all types of mosquito-borne viruses, such as EEE. Under the current scenario, sending samples to Albany is a necessity because the state laboratory tests for all types of mosquito-borne viruses, such as EEE and St. Louis Encephalitis (SLE), while the Taqman and RAMP methods only detect WNV. Testing for all types of mosquito-borne viruses ensures that field detection systems and laboratory detection systems are working, and that unexpected arboviruses do not pass unnoticed. SCVC and the ABDL should share lab facilities, wherever these facilities ultimately are built, to avoid duplication and facilitate coordination.

### 8.2 Professional Education

Continuing education provides professional staff with the opportunity to gather information on current and novel mosquito control techniques. Professional education for mosquito control workers includes:

- pesticide training programs
- equipment training programs
- computer software training programs
- field techniques training programs
- short courses in mosquito identification and control
- "Right to Know" training for hazardous substances
- attendance at state, regional and national mosquito control conferences

Pesticide applicators are required to acquire 18 hours of continuing education every three years in order to maintain licensing. Formal courses offered in the immediate area that would be of value to SCVC and ABDL personnel include species identification short courses taught at both Rutgers and Cornell. Travel restrictions make attendance at these courses difficult. Although Cornell is located in-state, the distance from the County means overnight stays are a necessity.

The Rutgers courses can be commuted to, but constitute out-of-state travel, which is currently restricted by County policy.

Attending general state, regional, and national mosquito control meetings benefits staff productivity and presents networking opportunities, allowing SCVC and ABDL staff to objectively compare the performance and quality of the County's program to that of others. Information from these various sources can then be incorporated into the existing program, directly upgrading quality. County policies regarding travel out-of-state by employees needs to be relaxed to ensure that professional staff retains professional qualifications.

Specifically, the productivity of SCVC staff, ABDL staff and the existing mosquito control program would benefit by allowing additional travel. Two regional meetings should be attended by two additional professional staff, such as an entomologist and biologist. There should be regular participation in additional regional (Northeastern Mosquito Control Association, Mid-Atlantic Mosquito Control Association, and New Jersey Mosquito Control Association, as examples) and national meetings (CDC annual WNV conference, AMCA national and Washington meetings, and the Society of Vector Ecologists, as examples) by the Superintendent and Lab Director. Suffolk County should also participate in the Associated Executives of Mosquito Control in New Jersey, an organization of superintendents and other key mosquito control officials that meets on a monthly basis. The Associated Executives provides a forum for officials with similar issues and problems to share information. It helps prevent "re-inventing the wheel" by more than one agency, saving time and money for all concerned. Technical staff should also attend professional training offered at Rutgers and/or Cornell in mosquito biology and identification to improve their mosquito identification and sampling skills. Such training will be especially valuable for field technicians responsible for retrieving traps from distant locations, such as the north shore, and utilizing proposed identification stations.

# 9 Technology Assessment

Mosquito and wetlands management require the use of sophisticated machinery and equipment of various kinds. This discussion is limited, as it is clear that technological innovation will make the current equipment and the recommendations here obsolete in fairly short order. Nonetheless, some broad guidance is offered in order to ensure the program maintains its current sophistication, and to provide certain necessary improvements.

## 9.1 Data Management

Mosquito management does not require sophisticated, statistically-based data analysis, for the most part. Certain environmental monitoring data sets (generally associated with wetlands management projects) may, but most will require the same kinds of simple trend analysis that the mosquito data calls for. However, especially for mosquito management, geographical trend analysis appears to be key. This calls for a reliance on GIS data management.

In addition, "once in" data entry is much preferable to re-entry or downloads/translations. Laboratory data entry can be streamlined by installing system desk tops at the analysis spaces. Field data entry is another issue. The customized VCMS system currently used does have advantageous remote entry capabilities, and is well-suited to the kinds of information generally produced by the surveillance and treatment programs. However, it does not interface well or easily with other programs. Although technical support is good, this does not cover the effort required to translate data into GIS formats. It is suggested that compatibility be a goal, as the lessons of the Microsoft era appear to be to that the trade-off in forsaking optimal programs for suboptimal is acceptable due to the benefits of interchangeability.

A fair degree of training will be required to ensure all necessary personnel are competent with the GIS software. However, this appears to be in accord with general County government policies.

To support GIS data entry, GPS needs to be universally available, in all equipment, and for all personnel.

### 9.2 Wetlands Equipment Needs

Compared to programs such as those found in New Jersey, Suffolk County does not need the extremely large, specialized marsh excavation machinery commonly used in jurisdictions that have very large wetlands. These machines, while highly productive, are difficult to move from one wetland to another without disassembly, which is a drawback in Suffolk County, with its numerous, small wetlands. On the other hand, many projects in Suffolk County will be larger than those addressed in Connecticut. Fortunately, Suffolk County already possesses an array of specialized marsh equipment that is well suited to local conditions. This equipment includes machines mounted on low ground pressure (less than two pounds per square inch) or amphibious tracks. When properly handled, these machines can operate on the soft terrain of Suffolk's wetlands with little or no adverse effects on sensitive vegetation. Current equipment can accomplish all the necessary tasks required to implement the Wetland Management Plan BMPs. However, additional equipment would speed up the pace of implementation. There is a particular need for personnel carriers to transport crews and supplies and for a long reach excavator to facilitate pond construction. In addition, at least one excavator should be fitted with a rotary excavating bucket to facilitate the sculpting of tidal channels and ponds.

### 9.3 Adulticiding Issues

Major choices for the County in terms of technologies for adulticiding include the means of application, choices between application platforms, and the use of models to support decision making and the proper application of the pesticides.

There is no question that ULV treatments are the application means of preference at this time. Suspending fine droplets of insecticide in the air allows for the mosquitoes to fly into the droplets and receive fatal doses. It is efficient, because the use of inert substances is minimized, and so aircraft with load considerations or trucks with volume limits can easily carry sufficient product to meet application requirements. Concentrating the pesticide also minimizes exposure to compounds that may not have received the same degree of regulatory scrutiny that the active ingredients did.

Thermal fogging, however, also has a place with SCVC for special situations. Fogging is essential if tire piles become a problem, as it can penetrate into the mass of the tires (where the ULV cloud would not). Fogging has also been suggested as a way of treating adult mosquitoes in stormwater systems (although Los Angeles has also developed a ULV delivery system).

SCVC currently uses a helicopter for aerial pesticide applications. For the near future, it is likely that aerial applications of pesticides will still be a program need. If progressive water management is successful, the incidence of aerial larviciding may fall dramatically, perhaps to the point where SCVC will seek a different delivery mode for infrequent applications to large marshes. For the near future, however, larviciding will continue; and there is no real prospect of avoiding adulticiding for health emergencies. Airplanes, a mainstay for many US programs, are not needed, and would be unwieldy for operations, given the relatively small areas treated by the County.

It also seems appropriate to continue to lease services from a private operator rather than to purchase a helicopter for County use. An analysis published for New Jersey suggests that the magnitude of the current program is at the cusp where helicopter purchase may be more economical. However, it is envisioned that larvicide applications, for one, will be greatly reduced within the operational life-span of a helicopter. A potential to share an aircraft with Nassau County has some attractiveness, as between the two Counties the need for the aircraft could certainly be justified. Both Counties have helicopters for other purposes, and so have appropriate maintenance and upkeep capabilities. However, if a major virus outbreak should occur, a shared platform could lead to disputes regarding first-use or other resource allocations.

It seems clear that there is a continuing place for truck adulticide application capabilities, as well. Truck applications can be more limited in area than air applications. There have been some concerns regarding the ability of truck applications to evenly distribute pesticide due to the presence of obstacles that can interfere with dispersion, as does not happen with aerial releases. In addition, because the release point of the material is close to the ground, they represent a higher potential human exposure than an aerial application, where the aerosol is well dispersed prior to reaching ground level. This potential is mitigated by County policies that avoid exposure to people outside of their homes at the time of application.. Truck treatments can be

more effective than aerial applications where the canopy is closed. They may also be more effective in denser woodlands for impacting canopy-dwelling mosquitoes. Where the canopy is more open, the generally greater dispersion of aerial applications makes them very effective at accessing the canopy from above and below.

SCVC has purchased an Adapco Wingman product to help guide aerial applications to optimize the pesticide dispersion pattern. SCVC has also obtained further calibration services from RTP Environmental through the Long-Term Plan to validate the model output. SCVC should be aware of future advances in mosquito application modeling, as this technology is relatively new, and so has the potential to quickly change in potentially major ways. SCVC should also carefully evaluate the utility of real time course adjustments, as there have been some concerns raised that the stable atmospheric conditions under which many applications occur lead to large dispersion changes as the result of small weather variations. This may mean that small changes in wind speed or direction may indicate large changes in aircraft direction. Multiple course changes over an application area may not be optimal for either efficiency or overall pesticide application reasons.

### 9.4 Laboratory Issues

The County has to carefully analyze fiscal and operational justifications for the construction of a BSL-3 laboratory. There are several important reasons to create a local BSL-3 facility:

- It will allow for the ABDL to conduct all of the kinds of sample analyses that it needs to do to fulfill its mission

- Because a laboratory upgrade is required in any case, it is prudent for the County to build the kind of facility that will serve it well for decades, rather than "making do" with an inadequate facility purely to minimize costs for the short-term

- Security and worker safety issues probably will require a facility that is "BSL-2+" in any case, so it makes sense to explicitly move to BSL-3 for somewhat modest cost increases from BSL-2+ levels.

Currently there are BSL-3 Laboratories at Plum Island and Stony Brook University operating in Suffolk County. SCDHS attempted to contract with Stony Brook University, but significant costs and lack of mutually acceptable financial terms prevented a contractual agreement from occurring. The facility at Plum Island is under the auspices of The Department of Homeland Security, and it has recently proposed the phase-out of the facility because of inefficient operations. The financial issues with Stony Brook University, and access issues (ferry only) and the uncertain future for Plum Island, do not necessarily preclude success if future negotiations were to be undertaken.

NYSDOH currently supplies the County with the testing information it would receive from its own BSL-3 facility. In previous years, due to budgetary limitations that limited the number of times the County could send samples to Albany, turn-around times on virus determinations was a public health issue. Quicker turn-around times (from 10 to 14 days to several days) reduce the impact of this. It should be understood that, at best, use of NYSDOH will result in turnaround times of at least several days, which would exceed turnaround times associated with use of a local facility. Turnaround times at such a local facility could potentially be consistently less than 24 hours.

The potential for resource limitations at the State facility is a concern that cannot be addressed. NYSDOH has (under the no-cost service) limited the number of samples that can be processed at particular times. This may be the key policy issue that determines the need for a Suffolk County facility. The County may be required to forego information necessary for public health decisions because of limitations on outside laboratory capacity. This is the most compelling point in favor of constructing a local BSL-3 facility since there is a significant need for rapid testing results to allow for swift formulation and direction of mosquito control strategies..

# 10 Adaptive Management

## 10.1 Introduction

The Long-Term Plan is not intended to be static. This is for two basic reasons. One is that changes in disease occurrence, technology, or conditions may require adaptations to the Long-Term Plan as currently envisioned. It may be that the basic direction described here is still the means by which the County wishes to achieve its ends, but exact methods need refining. If that is the case, the Long-Term Plan does not need to be entirely reworked, but merely massaged to account for the changes.

Secondly, some parts of the Long-Term Plan forthrightly express that necessary information to complete the planning process was not yet available, or could not be compiled at this time. As that information becomes available, changes in or more complete descriptions of plans will be constructed.

## 10.2 Structures and Mechanisms

The basic structure of the Long-Term Plan process should remain in place. The Steering Committee would still have overall policy responsibility, except now it will be for implementation of the Long-Term Plan, as well as residual planning processes and the adaptive management steps that occur. The Steering Committee would receive technical advisement by the Technical Advisory Committee, and the Citizens Advisory Committee may also continue to function as an outlet and input device to the Long-Term Plan for concerned citizens and advocacy groups. In addition, on wetlands issues, the reconstituted Wetlands Subcommittee and Wetlands Screening Committee will serve as valuable adjuncts to provide information to the Steering Committee for its decisions. It is clear that some level of expanded staff support will be required to accommodate the continued coordination and organization of these units.

Basic planning will not be addressed by the consultant team, but rather will become a SCVC responsibility. SCVC will support this planning responsibility by actively seeking cooperative exchanges with Federal, State, and local agencies and governments, and by reaching out to other interested parties and advocates. SCVC will drive much of this interaction as it maintains its

own knowledge base through participation in continuing education and attendance at professional meetings, and membership in professional societies and groups, but will also remain open to the suggestions and requests by local experts and other interested parties.

The mechanisms by which the Long-Term Plan can be amended include:

- Changes referenced in the Annual Plan of Work. Each Plan of Work will be required, in order to meet SEQRA requirements, to comply with conditions and thresholds set in the Long-Term Plan. This does not prevent minor changes to the Long-Term Plan from being introduced through the Annual Plans of Work. Each Annual Plan of Work will be appended to the Long-Term Plan to make that mode of change explicit.

- The Wetlands Annual Strategy Plan. This annual plan will advance the broad plans outlined in the Wetlands Management Plan through particular project designs and plans. This document was also identified as a means for adjusting the overall Goals and Objectives of the Wetlands Management Plan. Each Wetlands Annual Strategy Plan will be appended to the Long-Term Plan.

- The triennial Long-Term Plan Update. This report also provides a mechanism for adjusting plan Goals and Objectives, and determining if adjustments need to be made to specific areas of the Plan. Each one will also be appended to the Long-Term Plan.

All three of these reports will be reviewed by the Steering Committee, and submitted to the Legislature for approval. This ensures that necessary adjustments to the Long-Term Plan are incorporated in the same open and public process that produced the Long-Term Plan, and that adequate review is undertaken prior to adoption of any consequential change.

### 10.3 Examples of Areas of Adaptive Management

Clearly, as technology evolves, SCVC methodologies need to change. Upgrades of particular models, application technologies (such as nozzles and aircraft), implementation of new means of conducting WNV surveillance, and new mapping or other computer capabilities are clearly alterations that are countenanced within the Long-Term Plan. If new pesticides are developed, and it can be shown that they represent equal or less risk to human health and the environment,

these products may also be incorporated under the existing Long-Term Plan. However, major changes in policy or the adoption of a treatment means not discussed within the Long-Term Plan (genetic manipulation of mosquitoes or mosquito predators, for example) would almost certainly constitute a major change in the Long-Term Plan, and require substantial review under appropriate procedures and statutes.

Wetlands in general, and fresh water wetlands in particular, are areas where adaptive management is required. At this time, regulatory interpretations limit SCVC's ability to address issues relating to mosquito breeding and presence in these areas. There are three key, interrelated issues that will be addressed over time under the adaptive management procedures of the Long-Term Plan:

- Adjustments to current SCVC procedures to account for vulnerable species or areas. SCVC, NYSDEC, the towns, and other interest groups will work closely together to identify specific organisms or areas where sensitive mosquito management is preferred. SCVC has already worked with NYSDEC to identify tiger salamander habitats, for example, and has adjusted its activities to reduce the chances that harm might befall these creatures. Similarly, other species of special interest, or even certain sites of special concern, will be discussed with the aim of finding consensus between perceived mosquito management and environmental protection needs.

- Related to this is SCVC's interest in reconsidering the buffers set cooperatively by SCVC and NYSDEC to fulfill NYSDEC's perception of regulatory needs regarding wetlands and pesticides labels. SCVC believes that a more nuanced description of many of the wetland areas it undertakes its work can allow for reconsideration of the existing buffers. At this time, there is a fixed 150 foot buffer from fresh water wetlands, and 100 foot buffer from open water in general. The results of the Long-Term Plan risk assessment should be useful in determining, on a scientific basis, exactly what distance from open water will serve as protection from impacts.

- Additionally, NYSDEC may wish to consider the current prohibition of habitat manipulation in fresh water wetland settings. These regulations have served as strong tools to preserve fresh water wetlands, but it may not be in society's overall interest to continue to

use pesticides as the preferred means of managing mosquitoes in fresh water environments. Alternatives to pesticide use should be considered, and, if found acceptable by the NYSDEC, implemented if they accord with the principles espoused in the Wetlands Management Plan, Best Management Practices Manual, and Wetlands Impact Assessment, as developed by the Long-Term Plan.

Another wetlands issue that lends itself to adaptive management is the concept of salt marsh health, especially as it relates to diversity of habitat and organisms for Suffolk County's marshes, in particular. National understanding of these concepts has been advanced recently through on-going research, but much work in salt marshes appears to be site specific. Some research needs to be conducted in Suffolk County marshes, particularly those on the south shore, to determine if the general concepts that seem to apply to many other areas also apply to these marshes and their own peculiar, microtidal setting. Fostering a greater conceptual understanding of the general processes that operate in County marshes can only aid to the restoration efforts that SCVC intends to either conduct or assist in.

# 11 Resource Commitments

## 11.1 Personnel

In the proposed 2006 County budget, the County Executive added two positions to SCVC (an Entomologist and an Engineering Aide), which were described as the highest priority positions needed to begin implementing the Long-Term Plan. The ABDL received two of its requested positions. These positions are proposed to be funded from Quarter-cent revenues.

Positions identified by SCVC to meet needs for the Long-Term Plan appear to require approximately $600,000 in salary commitments (at entry level salaries), if all were to be filled. Approximately half of that salary commitment would appear to meet the requirements associated with Quarter-cent funding (if available). Staff associated with the on-going construction-restoration activities in wetlands may also be eligible for cost sharing under various environmental restoration funds at many levels of government.

The ABDL laboratory positions, when fully needed, appear to require approximately $550,000 in salary commitments. The ABDL position request assumes the construction and full staffing of the requested BSL-3 facility. A major contingency is the development of an alternative surveillance tool for WNV detection to replace dead bird analysis.

## 11.2 Equipment and Other Capital Needs

Marsh management equipment needs appear to require approximately $250,000. These kinds of equipment often qualify for match funding through State restoration bonds and other funding opportunities.

Installation of at least one adjunct Identification Station in an existing County facility to serve the East End is warranted. Costs associated with such an installation (some room modifications, such as paint and installation of appropriate plumbing, and equipment such as refrigerators and microscopes) appear to be relatively minor (less than $25,000).

Planning for, procuring, and constructing a BSL-3 laboratory is a major undertaking. This cost needs to be carefully estimated before the County commits to such a project.

### 11.3 Ancillary Funding

Associated with changes in wetlands management are many ancillary funding commitments that the County should be aware of, even if it does not intend to commit to at this time. Some of these costs may be absorbed by other Departments in the regular course of duties, and some may require new positions (if addressed by County personnel) or consultant costs (if professional services are arranged for). Although SCVC is proposing a major staff expansion to address marsh management, much of that staff will be committed to "present-day" projects. Those active construction-restoration projects are, in fact, eligible for support from Federal, State, and even County restoration and environmental management funds.

But project planning and on-going monitoring activities (pre- and post-project) are not so eligible in most cases. These costs can be significant. Despite substantial in-kind contributions from County, USFWS, and Stony Brook University staff, OMWM monitoring at Wertheim has averaged approximately $100,000 per year in consultant costs (even with reliance on low-paid interns for routine work). These requirements will multiply, as the number of completed projects rises, where monitoring is still required, and the pace of active projects increases with experience.

Planning for these very complicated projects may involve computer modeling and intricate GIS applications. It also may involve making good and careful environmental measurements – pre-project monitoring, but prior to any regulatory requirements. The County is fortunate that other levels of government and several non-governmental organizations are expressing interest in assisting the County with project planning, and may also assist in monitoring duties.

However, it is very important for the County to discuss with New York State the need to recognize fiscal realities in project monitoring. If the State cannot provide substantial technical assistance towards these projects, and will not relax monitoring requirements that exceed those required by other north-east US governments, then the County must be prepared to assume some substantial obligations to meet monitoring needs associated with the Wetlands Management Plan.

# 12 Implementation Recommendations

In order for the Long Term Plan to be successfully implemented, a number of actions are required to be taken by involved stakeholders, including SCDHS and SCDPW, local elected officials from the County, townships and villages, State and Federal agencies, involved non-governmental stakeholders such as Ducks Unlimited and The Nature Conservancy, and the general public.

## 12.1 Actions by County Program Managers in SCDPW and SCDHS

**Public Outreach**

1. Increase public contact and vector control information dissemination through public meetings, brochures, fact sheets, etc., and actively participate in Mosquito Awareness Week.

2. Conduct outreach programs and information dissemination in Spanish and other languages in areas of the county where English may not be the residents' first language.

3. Expand public and municipal education outreach by incorporating tire management as a means of vector control. Include tire collection as part of routine sanitation?or maintenance activities.

4. Partner with Cornell Cooperative Extension Service in educational mailings/meetings targeted to specific audiences for implementation of irrigation practices that prevent or minimize the potential for mosquito breeding.

5. Conduct tailored outreach programs to municipal highway departments and programs regarding stormwater structures as mosquito habitat (including SCDPW).

6. Increase efforts to educate parties responsible for storm water management to utilize methods that do not increase the potential for mosquito breeding or introduce contaminants to wetlands.

7. Create Listserv for adulticide applications in order to expand public notification procedures.

8. Provide the resources necessary to update and improve the SCVC website in order to provide the public with timely information and descriptions of vector control activities being conducted in various areas of the county.

**Surveillance**

9. Provide the necessary resources and support implementation of efforts for increased frequency and greater number of recharge basin sampled.

10. Provide the necessary resources and support implementation of efforts for increasing the number of catch basin sampled.

11. SCVC and the ABDL should implement expanded CDC light trap surveillance as outlined in Section 3.

12. Establish New Jersey trap stations on Fire Island as outlined in Section 3.

13. Conduct the necessary research and fieldwork to locate ambient trap stations (New Jersey traps preferred).

14. Provide the necessary support and resources for SCVC to establish Identification Stations in existing County facilities.

15. Provide the necessary support and resources for SCVC and the ABDL to develop and conduct a Fishers Island disease surveillance program.

16. Encourage and support efforts by the QA/QC team and the ABDL to develop an alternative WNV technique to replace dead bird analysis.

17. Encourage and support SCVC efforts to establish landing rate sites.

18. SCVC program managers should reconsider whether the benefits associated with the VCMS system exceed the difficulties in translating its data in GIS.

19. The ABDL should produce annual reports on surveillance analysis.

**Biocontrol**

20. SCDPW should provide sufficient resources for SCVC to replace use of Gambusia with fathead minnows, including development of the capability of farming the fish in-house if economically viable.

21. SCVC should follow developments in New Jersey, where culturing of predatory copepods is being attempted, and implement this technique if feasible.

**Water Management**

22. SCVC should implement the BMP Manual.

23. SCVC's should plan for and conduct projects to displace aerial larviciding.

24. The long-term goal must be to assess 9,000 acres of marsh for needed management activities over 10 years.

25. SCVC and the SCDHS Office of Ecology should work with NYSDEC to evaluate fresh water management prohibitions.

26. SCVC should work with towns and other stakeholders to implement appropriate water management projects.

27. County program managers should develop programmatic means of improving County marsh health.

**Larviciding**

28. SCVC should coordinate cooperative actions regarding vulnerable species in fresh water habitats.

29. SCVC should record and analyze dip counts to relate to treatment reductions.

30. SCVC should phase out use of long-lasting larvicidal products (e.g., Altosid XR briquette), developing alternative treatment practices and schedules.

31. If New Jersey research supports the effort, SCVC should conduct its own copepod research (with a catch basin focus) to reduce larvicide applications.

32. Develop a means of conducting routine efficacy testing on individual applications.

33. Prepare and issue an appropriate means for enabling a contract with an organization capable of developing a professional resistance detection program.

34. On an annual basis, SCVC should prepare larvicide efficacy reports.

**Adulticiding**

35. SCVC should maintain and upgrade the recently installed Adapco Wingman system.

36. SCVC should establish the comprehensive efficacy program outlined in Section 8.

37. The County should support bird dispersal and migration research as a means of understanding EEE dynamics.

38. SCVC should conduct necessary research and outreach to establish an effective means for Culex adult mosquito control.

39. SCVC should install/purchase GPS for all equipment and personnel.

40. SCVC, after careful analysis of the risk assessment results, should work with NYSDEC regarding wetlands setback requirements based on natural resources considerations.

41. Prepare and issue an appropriate means for enabling a contract with an organization capable of developing a professional resistance detection program.

**Administration**

42. SCDHS and SCDPW administrators should redistribute surveillance responsibilities.

43. SCVC should implement its organizational .restructuring.

44. SCDPW and SCDHS should provide budgetary support to enable SCVC and the ABDL to establish needed new positions.

45. SCDHS should plan and construct the ABDL BSL-3 lab.

46. SCDPW and SCDHS should encourage personnel to participate in extensive continuing education programs and scientific meetings.

47. SCVC and SCDHS must produce required reports (such as the Wetlands Strategy Plan, the Triennial Report, efficacy results, and the Annual Plan of work) and public outreach material (such as updated brochures and website information sets).

### 12.2 Actions by County Executive and Legislature

**Public Outreach**

1. Provide the resources to allow for implementation of irrigation practices education (through Cornell Co-operative Extension).

2. Establish responsibility in a particular agency to implement private storm water system maintenance education.

3. Provide public relations opportunities to enhance the public image of SCVC to encourage public and government cooperation with its activities.

**Surveillance**

4. Provide necessary funds and institutional approvals to establish Identification Stations within existing County properties.

5. Reconsider County vehicle policies regarding overnight, at-home possession, to allow for more efficient surveillance activities.

6. Provide sufficient number and field appropriate vehicles for surveillance activities.

**Water Management**

7. Actively support the use of Water Quality Protection (1/4% sales tax) Funds for wetlands initiatives.

8. Take the necessary steps to establish, support, and participate in the Wetlands Screening Committee.

9. The County should consider policy changes that could result in programmatic means that will improve County marsh health, such as permitting of coastal septic systems, or other options that may indirectly affect coastal water quality of marsh environments.

**Adulticiding**

10. The county should provide necessary funds to support bird dispersal and migration research.

**Administration**

11. The county should provide institutional support to allow the redistribution of surveillance responsibilities.

12. Implement organizational reorganization.

13. Fund and establish essential new positions.

14. Provide the means to plan and construct ABDL BSL-3 lab.

15. Reconsider current policies regarding employee out-of-state travel to allow for appropriate professional development.

## 12.3 Actions by Other Local Government

### Source Control

1. Encourage towns and villages to work with SCVC to address stormwater structures and their potential to breed mosquitoes.

2. Improve the waste management and parks departments tire management practices.

### Water Management

3. Towns and other levels of government should participate in the Wetlands Management Plan to work with SCVC and others to implement appropriate water management projects.

4. Towns and other interested levels of government should participate in and support the Wetlands Screening Committee.

5. Town natural resource divisions should participate in the Wetlands Subcommittee.

6. Towns and other interested levels of government should seek to develop programmatic means that will improve County marsh health, such as zoning and other planning steps that can affect coastal water quality and marsh environments.

### Larviciding

7. Town natural resource agencies should conduct cooperative actions regarding vulnerable species in fresh water habitats, such as sharing any information relating to sensitive species or habitats.

### Adulticiding

8. Town natural resource agencies should provide material and political support for bird dispersal and migration research.

## 12.4 Actions by State or Federal Governments

### Water Management

1. NYSDEC: NYSDEC should work with SCVC to evaluate fresh water marsh management prohibitions in light of other states' regulations and experiences, as well as particular habitat and ecological settings in Suffolk County.

2. NYSDEC and others (NYSDOS, USEPA, USACOE, USFWS, NPS): These agencies should work with SCVC, towns, and other organizations to identify, permit, and implement appropriate water management projects, providing technical input and guidance where expertise is available.

3. NYSDEC: NYSDEC should make a policy decision to participate in Wetlands Screening Committee.

4. NYSDEC and others (NYSDOS, USEPA, USACOE, USFWS, NPS): These agencies should continue to participate in the Wetlands Subcommittee.

5. NYSDEC and others (NYSDOS, NYSERDA, USEPA, USACOE): These agencies should actively support the use of restoration grant funds (and other available funding mechanisms) for potential wetlands projects.

6. NYSDEC: Means to issue general permits, where appropriate, to implement low-impact BMPs on an expedited basis need to be explored with SCVC and other interested parties.

7. NYSDEC and others (NYSDOS, USEPA, USACOE, USFWS, NPS): These agencies need to support research and other mechanisms (workshops, demonstration projects, planning grants) that will result in the development of programmatic means to improve County marsh health.

8. NYSDEC: A priority to enable implementation of progressive water management in the County is that NYSDEC develops Unit Management Plans for State marsh holdings.

**Larviciding**

9. NYSDEC and others (USEPA, USFWS, NPS): Natural resource specialists should work with SCVC and other local experts to identify potentially vulnerable species in fresh water habitats.

**Adulticiding**

10. NYSDEC and others (USEPA, USFWS, NPS): provide material and political support for Long Island-relevant bird dispersal and migration research.

11. NYSDEC: NYSDEC and SCVC should carefully examine the results of the risk assessment to determine if current wetlands and aquatic habitat setbacks should be reconsidered.

### 12.5 Actions by Other Interested Parties (NGOs, Civic Associations, interested individuals)

**Water Management**

1. Interested parties should work with SCVC and towns to implement appropriate water management projects.

2. Interested parties should participate in the Wetlands Subcommittee.

3. Interested parties should work with the County and towns to identify implementable programmatic guidelines that can be demonstrated to lead to improvements in County marsh health. Sites are needed for demonstration projects, and appropriate background research/studies are needed.

**Larviciding**

4. Interested parties with appropriate natural resource expertise should assist SCVC in identifying potentially vulnerable species in fresh water habitats.

## Adulticiding

5. Interested parties should support (and potentially assist in) bird dispersal and migration research.